BRITISH AVIATION

The Great War and Armistice
1915–1919

Idyllic flight test on the Thames. Sopwith Schneider with experimental Linton Hope floats giving 8 mph increased speed. (*Courtesy The Royal Aeronautical Society.*)

BRITISH AVIATION

The Great War and Armistice 1915–1919

HARALD PENROSE

FUNK & WAGNALLS
NEW YORK

For

ARTHUR DAVENPORT, C.Eng., F.R.Ae.S.
long of Westland
who regarded his test pilots with
unfailing friendliness and trust throughout
eight years as Chief Draughtsman
twenty-one years as Chief Designer
six years as Technical Director

Library of Congress Catalog Card Number: 70–92036

Published by Funk & Wagnalls,
A Division of Reader's Digest Books, Inc,
by arrangement with Putnam & Co, Ltd

Printed in Great Britain

CONTENTS

INTRODUCTION

In order to understand the complexities of today it is of absorbing interest to discover how they are rooted in the past; to stir the dust of older footsteps; to hear long-forgotten voices; to see an ancient sunlight; to feel the pulse of vanished times; to conjure a way of life that was not ours yet is recognizably like it, swayed by the same impulses, pleasures, endurances, and fears.

Hilaire Belloc defined the task of those who write of the past as: 'First, the mind must grasp the inner nature of historic change, and therefore must be made acquainted with the conditions of human thought in each successive period, as also with the general scheme of its revolutions. Secondly, the external actions of men, the sequence in dates and hours of such actions, and their material conditions and environment must be strictly and accurately acquired. Neither of these two foundations, upon which repose both the teaching and the learning of history, is more important than the other. Each is essential. But a neglect of the new emphasis which one or the other demands, though both be present, warps the judgment of the scholar and forbids him to apply this science to its end, which is the establishment of truth.'*

Unless one is a professional historian it is improbable that such precise balance can be attained, yet it is equally unlikely that an academic historian would be aware of the many diverse techniques of aeronautics and their implications. To assume the mantle of historical chronicler is therefore a task dared only because a long career in the aeronautical industry enabled me to understand the atmosphere of early days and to meet so many of the key figures. Even as a youngster I saw most of the RFC aeroplanes mentioned in this book, and later flew some of the more significant, such as the Avro 504K, S.E.5a, Bristol Fighter, D.H.9 and 9A, and even the French Morane and Nieuport. Though interpretation of these and other aeroplanes – their handling quality and operational efficiency, or their constructional and technical achievement – was aided by personal experience of design and manufacturing responsibility, as well as test flying, the machines were far less important than the men, the pioneer personalities who made them possible. Their pursuit of flight with aeroplanes of their own inspiration was no mere job but a vocation, and it is indicative of their strength of purpose that they established an industry which twice saved Great Britain.

When I began assembling material for this saga of the British aircraft industry I recontacted all traceable pioneer-constructors and many of

***On Anything* (1910), republished by Penguin Books *Selected Essays*.

their later colleagues. Since then many have gone. The last lingering essence of their achievements is fading away, submerged in the pursuit of new technologies and the manipulations of industrial finance and political direction. Even the once famous names are being forgotton except by a few. Yet they are worthy of study and remembrance, both as men and as the begetters of the air age.

To focus the perspective, hundred upon hundred references have been consulted, whether histories, newspapers, aeronautical journals, or technical documents and patents. As an invaluable guide on aircraft sequences and details, J. M. Bruce's masterly *British Aeroplanes 1914–18* was of greatest help, as were the specialist authors of other books in the Putnam series specifically describing the productions of individual manufacturing companies. Sources are too innumerable to mention individually, but I am indebted to authors, publishers, and letter-writers alike from whom I have either quoted or gleaned information, and particularly to many histories and biographies from which I have recaptured numerous facets confirming my recollection of events and people.

A previous volume, *British Aviation: The Pioneer Years*, told how the industry began, but now the story continues as a self-contained volume describing the evolution of the major British companies in World War I – then known as the Great War – and the first impact of peace-time conditions. Though it could help in appreciating the character and early struggles of the aviation pioneers if the previous book is read, it is not essential for continuity because the episode of war brings different issues. Here was a period of intense design development, when for the first short-lived time there were no restrictions on expenditure in the endeavour to keep British aircraft one step ahead of the enemy. Above all, this is a story of war and its overwhelming impact on the aircraft industry. The difficulty has been to decide what to eliminate in so great a canvas yet still present a true picture.

In a sense one is writing an historical novel; yet it is factual and therefore subject to limitations not felt by the novelist, for its purpose is to portray the major factors which influenced the growing development of an industry which has always led the way in scientific thinking and thus became the springboard of an ever-extending range of industrial diversities which were originally dependent upon it. In order to simulate the reality and immediacy of everyday life in those times where, just as now, events were always too near for focus, the horizon circumscribed, and the future scarcely guessable, it seemed better to eliminate all hint at direct comparison between achievements of those days and our vastly different modern knowledge. But the lessons are there.

Harald Penrose

April, 1969

CHAPTER I

FOG OF WAR
1915

'Lords and Commons of England, consider what nation it is whereof ye are and whereof ye are the Governors: a nation not slow and dull, but of a quick ingenious and piercing spirit, acute to invent, subtle and sinewy to discourse, not beneath the reach of any point, the highest that human capacity can soar to.'

John Milton (1643)

I

THROUGH THE starlit night the New Year bells all over Europe pealed their message of hope, and everywhere men of goodwill prayed that 1915 might bring peace to the world.

But industry was getting into its stride for war: more guns and shells, more and more rifles; more waggons and lorries; more ships; more aeroplanes. When hostilities had begun in the preceding August barely 1,000 men constituted the British aircraft industry which was disparagingly referred to by the bureaucrats of the Army, Navy, and Government as 'the Trade'. Only nine aircraft manufacturing companies in Britain were reasonably well known: A. V. Roe & Co Ltd; Sopwith Aviation Co Ltd; Handley Page Ltd; British and Colonial Aeroplane Co Ltd*; Grahame-White Aviation Co Ltd; Blackburn Aeroplane and Motor Co Ltd; Aircraft Manufacturing Co Ltd; Martin and Handasyde Ltd; Short Bros Ltd — and the armament firms of Vickers Ltd and Coventry Ordnance Works Ltd had also played a part. For the rest there were the great Cowes boat-builders J. Samuel White Ltd and S. E. Saunders Ltd, and a dozen or more minor constructors such as Hewlett and Blondeau Ltd, White and Thompson Co Ltd, H. J. Mulliner Ltd, Pemberton Billing Ltd, or the foreign licensees, the British branch of Blériot Ltd and the British Caudron Co Ltd. Soon their number was doubled — but only the Royal Aircraft Factory at Farnborough had widely ranging design and construction experience, and ability to tackle aerodynamic and structural problems in scientific manner.

Five months' tremendous endeavour and recruitment in the industry had resulted in less than 200 landplanes and 50 seaplanes, and of the total about 60 must be regarded as experimental. Yet it was already clear that

* Later The Bristol Aeroplane Co Ltd.

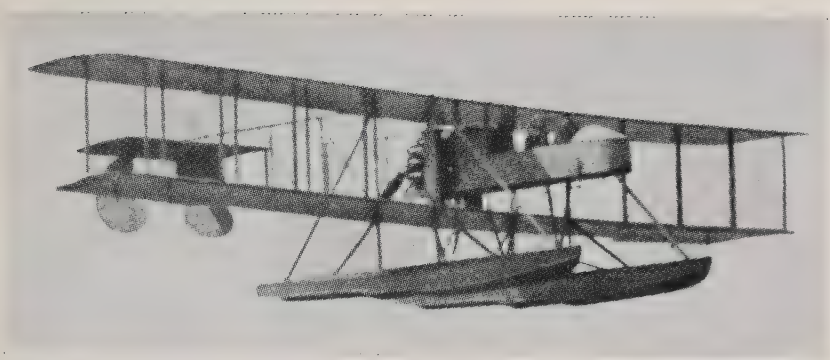
aircraft would be needed in hundreds and scores of hundreds unless victory was surprisingly and quickly attained. Of that there was no sign. In France the guns spasmodically thundered. The war was in a phase of stalemate.

The *Daily Graphic* of 1 January offered a note of encouragement. 'The year that begins to-day is full of hope for Great Britain and her Allies,' ran its editorial. 'The war forced upon us five months ago may last many months, but we may fairly hope that it will not outlast the year. Our enemy's confident calculations have already been disproved by experience. It is true the Germans occupy nearly the whole of Belgium, a considerable portion of France, and an appreciable slice of Russian Poland, but at no point can they feel sure of retaining what they hold, still less of making any advance. If Germany had foreseen this result after five months of hideously costly warfare, she would never have started. Our confidence in the ultimate issue is based not only on comparison between the expectations of Germany and her actual results, but on knowledge of the spirit of our own people.

'In all parts of the United Kingdom, Dominions, India, and the Crown Colonies, an identical note is struck – determination to see this struggle through whatever the cost. Already the effect of the struggle has been to create a new spirit of unity. Old shibboleths have been forgotten; old quarrels laid aside. We stand united as a Kingdom and an Empire as never before. The war has awakened realization of the responsibilities of life and understanding of the call of duty, and it is our moral strength welding the immense resources of our Empire that will command success.'

Maybe; but though our young men had flocked to the Colours as if to a crusade, the true temper of the people had yet to be tested; nor was it known that the appalling extent of casualties had been suppressed – for the French infantry, conspicuous in red breeches and blue coats, were

The first B.E.2 built by the famous motor-boat firm S. E. Saunders Ltd of Cowes. Behind is the Perry-Beadle 1914 flying-boat which used the lower wing as sponsons. (*S. E. Saunders.*)



A few Wight seaplanes had early use as U-boat spotters, though restricted to smooth water operation. Uniquely for a pusher the 63 ft span wings could be folded.

already reduced by some 900,000 killed, wounded, or made prisoner, and even the small British Expeditionary Force had lost over 90,000. But the German Army had overrun itself. The Battle of the Marne shattered their plan to break through near Mons and in a great sweeping movement to pivot the French Army on itself and isolate Paris. Instead the Germans were forced back to the Aisne.

An occasional aeroplane, lifting from a little airfield in the quiet countryside well behind the fighting front, might see all Flanders and Picardy as a land of peace – until presently distance revealed faint spidery lines etched across the forward view, which in a few more minutes became emphatic zigzag ditches converging like crazy tributaries into deep front-line trenches, reaching from horizon to horizon. But there were all too few aeroplanes.

Quiet though that great stretch of countryside seemed from the air, it was very different for the soldiers sticking out bitter winter days, shift by shift, in those miles of rain and drain-swamped ditches that stretched from Switzerland to the North Sea in two continuous, opposing entrenchments sometimes a mile or more apart, at others only a few yards as at Arras.

Describing the battle-front an eye-witness said: 'The fighting is over ground where both sides have been excavating for weeks in all directions, until it has become a perfect labyrinth. A trench runs straight for a considerable distance, then suddenly forks in three or four directions. One branch may lead into a ditch full of water, used in drier weather for communication; another ends abruptly in a cul-de-sac, probably an abandoned saphead; a third winds on, leading into galleries and passages further forward. Sometimes when new ground is broken, the spade turns up long-buried dead, ghastly relics of former fights; and everywhere the earth is ploughed and furrowed by fragments of shells and bombs, and distorted by mines. The life led by the infantry of both sides is a strange, cramped existence, with death always near, either from missiles above or mine explosions beneath; a life which has one dull, monotonous background of mud and water.

'Some of the captured Germans take a gloomy view, criticizing their

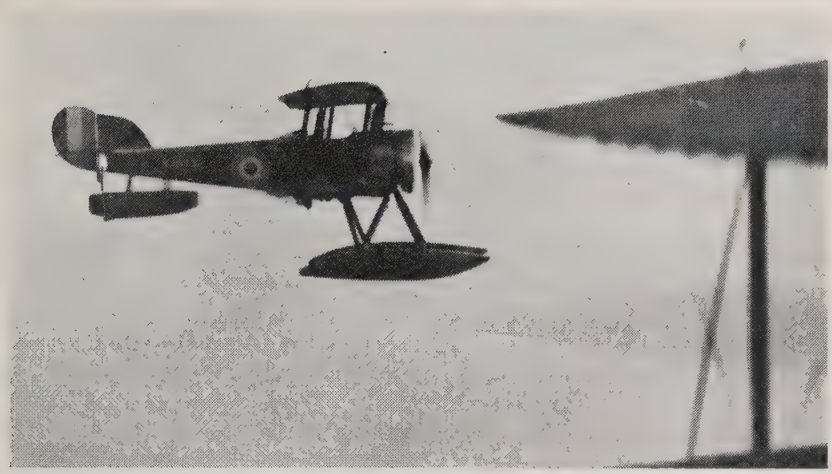
leaders, and appear sick of life in the trenches, yet firmly believe Russia has suffered decisive defeat, France is exhausted and ready to make peace, and England is decadent, with her people engrossed in football matches. This is because we still rely on what appear half-measures – such as voluntary service – and unlike other nations are not enrolling our entire manhood for the prosecution of war. Neither the pinch of real want nor lack of men and material have been felt by the Germans, nor consciousness of defeat. Their Press is doing its best to inspire fanatical hatred against us, and foster conviction that it is we, inspired by jealousy, who have by intrigue and treachery raised a host of enemies against them.'

Appalling though conditions were on the fighting front, the British public, islanded in safety, had not awakened to full reality, even though every town and village had its khaki-clad soldiers, and newspapers were anxiously commenting on the horde of Belgian refugees entering Folkestone by every available boat. In government circles there was talk of a million more men for the armed forces; yet to the man in the street, fighting seemed a professional business and not of immediate concern, for violent change has no part in British make-up. Whether squire, businessman, clerk, or farm labourer, his nature was to preserve all that was long accustomed, despite growing sense of injustice among factory workers and miners. It was typical of national character to feel dissociated from a war remote and invisible across the seas. In any case had they not been told by the Government that the duty of every subject was to back national effort with 'business as usual'? So there was still racing and football and betting, and sociable evenings at the pub where a man could grouse at lack of news of a war regarded almost as a sporting event.

Indeed, there was growing suspicion that information was being withheld – as most certainly it was, for only now did one learn that the battleship *Bulwark* had blown up in Sheerness harbour a month ago; and when the great warship *Formidable* was sunk on New Year's Day by U-boat it was not revealed that this was off Lyme Regis lest people suspected that if submarines could so easily slip past the Navy's eye in home waters we might really be in for trouble. Assault on the very threshold of England was one thing, but far-away France and Flanders was another; the stalemate might be a natural winter pause giving time for recruitment to Services and industry, and allow stock-piling of armaments.

That suave monocled editor of *The Aeroplane*, C. G. Grey, whose self-imposed mission was sardonic criticism, for once wrote reassuringly: 'Since war broke out, the aeroplane has done such surprising things that even the least imaginative begin to realise that it affords a vital adjunct to naval and military operations, and possibly even a vehicle for ordinary use when war ceases. That Germany has failed to obtain command of the air is a curious freak of fate. By all rules our little air fleet ought to have ceased to exist, along with our "contemptible little Army",* about a week after war was declared.

*The Kaiser's description of the British Expeditionary Force.



A Sopwith Baby, often still referred to as a Schneider because of its ancestry but differing in having an open horseshoe cowling and a 110 hp Clerget; viewed from a Short 184. (*T. Elsemore.*)

'On the brighter side, our country produces the fastest machines in the world for their power in the form of small biplanes, commonly known as Tabloids – originated by the Sopwith Company and made with variations by the Martin-Handasyde, Bristol, and Armstrong Whitworth concerns. The big seaplanes built by the Short, White, and Sopwith firms are similarly the fastest of their type, and the Avro is the most efficient two-seater of its power anywhere. All this has been done, notwithstanding official discouragement, by sheer British obstinacy, and on the same principle the Aircraft Manufacturing Company has built a big business in turning out machines better than their French originals, and the Vickers Company has produced a really useful Gun-carrier.' Despite this flattery C. G. Grey was being less than fair in ignoring Farnborough, whose B.S.1 designed by de Havilland originated the small fast biplane class.

Only in the last five years had the world's aircraft industry taken root – with the French, British, and Germans leading, and the Americans lagging despite origination of practical flying in the hands of the Wrights. Pioneer designer-builders initially had been immensely pleased if they could even get their creations into the air. Theirs was a sense of quest, of opening new horizons, of being the first to explore the skies and achieve enrichment of their world. They were gratified that after long centuries of dreams and disappointing experiment man had suddenly acquired the greatest instrument of movement in all human experience. Few saw that civilization had made a Frankenstein discovery which might devour it.

By trial and error the mode of flight had been learned, together with the manner of imparting requisite strength to structures without exceeding the essential of light weight. Only by restricting wing loading to a few pounds for each square foot of surface could aeroplanes be propelled into

the air by the low-powered and heavy engines of those earliest days. Not until the advent of the star-like rotating engine, introduced by the Gnome, was a sufficiently light and reliable power unit obtained.

By 1910 government-employed scientists had been established at the Army Aircraft Factory located at Farnborough under the supervision of Mervyn O'Gorman, working in collaboration with others of the National Physical Laboratory at Teddington, directed by Dr R. T. Glazebrook. They elaborated contemporary theories of aerodynamics based on applied mathematics and wind-tunnel tests, and investigated probable structural loads imposed by widely ranging flight conditions, relating them to methods of strength calculation already developed by civil engineers for bridge design. Leading aeroplane companies soon began to employ mathematicians for the same purpose, though working more empirically than Farnborough and Teddington researchers from whom they gained benefit of more specialized experience. By the time the Great War commenced, broad standardization of design and construction had been attained – resulting in supremacy of the biplane because it ensured the lightest and most rigid structure – for although the principle of cantilevers was well known, such wings would be too heavy for the power of current motors, making take-off runs impossibly long for the small fields available.

Slow progress of suitable internal combustion engines dictated the development rate of new aeroplane design. By 1915 the biggest standard rotary gave 100 hp when new and tuned. The best water-cooled stationary was the vertical six-cylinder Austro-Daimler Beardmore of 120 hp, weighing 5 lb/hp excluding radiator and coolant, compared with 2·9 lb/hp for the air-cooled rotary Gnome. The biggest, but somewhat erratic engine, was the French-built 200 hp Salmson fourteen-cylinder two-row water-cooled radial which Shorts proposed for their new Type 166 torpedo-

A Short 166 ready to be launched from the slipway at Hamble, scene of pre-war yachting; the *Crab and Lobster* at Warsash can be seen in the distance.

carrying seaplane. Many other engines were in design or development phase, but the weight problem dictated to most aircraft designers the merits of relatively low-power rotaries, even though this resulted in a mere 75 lb payload of guns and ammunition for a machine the size of the single-seat Sopwith Tabloid which weighed less than 1,200 lb all-up, in the proportion of some 30 per cent for structure, 38 per cent for power-plant, and 15 per cent for fuel – leaving only 17 per cent for pilot and armament. Even a two-seater with proportionately larger wings, such as Farnborough's new B.E.2c, could carry only 160 lb of bombs and guns, despite the advantage of the engine becoming a smaller proportion of total weight as aircraft size increased. Aircraft design was so marginal that, for the foreseeable future, hope lay only in developing greater horse-power, enabling slightly increased wing loading and affording a more compact machine of slightly lower drag.

This drag, or resistance to the airstream, was another fundamental obstacle, though the amount was absurdly small. At the 100 ft/sec adopted as standard for comparisons, the drag of a single-seater might be some 110 lb, of which the body caused 44 lb; the flying surfaces, wires and struts 35 lb; and the cleanest undercarriage 16 lb with miscellaneous items of 15 lb. While an idealized aeroplane might save 50 lb by eliminating external bracing and retracting the undercarriage, mechanical problems and structural weight made this impossible because wing loading would increase. The practical likelihood was secondary reduction of fuselage drag and still less for wings – though broad principles, backed by practical experience, had already revealed that long span, high aspect ratio made all the difference in climb compared with stubby wings, but the latter were more effective for speed. Because of the unidentified effect of induced drag, all aerodynamic experiments were standardized with an aspect ratio of 6, but the scale effect of small wind-tunnel models remained open to doubt, for it was confusing that when individual resistances of parts were added, the total was often less than the measured drag of the completely assembled model. In turn this could be either greater or less than that of the full-sized aeroplane judged by worse or better performance than the estimate.

What with propellers failing to achieve calculated efficiency, engines down in power, cooling resistance greater, unrecognized aerodynamic interference between components, uncertainty of control response, stability, and general handling characteristics, let alone the overwhelming problem of small structural weight for maximum strength and absolute integrity, every new aeroplane was an exciting but often perilous gamble.

2

If advertisements were index of the increasing income of major War Office and Admiralty aircraft contractors, those currently appearing in the aeronautical Press revealed rapidly improving prospects. Previous advertising expenditure had been cautious, but now full pages were taken for prestige.

Of component manufacturers who advertised, there were Rubery Owen for strainers, metric bolts, pressed steel fittings, and cold-drawn tubes; Accles and Pollock specializing in bent tubular work; R. W. Coan for aluminium castings; Thos Firth for steels; the British Wright Co for Ogilvie airspeed indicators; British Emaillite for dope 'tight as a drum'; Cellon for 'the dope of proved efficiency'; Shell 'the spirit of the Allies'; Chauvière's Integral propellers; shock absorber cord from James Ball & Co. Yet these suppliers represented only a beginning. Other firms were being introduced to the complicated production programme as quickly as they secured approval from the official Aircraft Inspection Department, known as the AID.

Geoffrey de Havilland in the pilot's seat of an early B.E.2a. The RFC's first VC was won by Second Lieut W. B. Rhodes-Moorhouse while bombing with one of these machines. (*Imperial War Museum.*)

Although full to capacity with production orders, every pioneer aeroplane manufacturer was engaged on new designs, some officially sponsored, others private ventures based on independent study of probable Military or Naval requirements – though the former was basically committed to officially sponsored types designed by the renamed Royal Aircraft Factory, known as the RAF.

Most widely spread contracts were those for the B.E.2c. It was Farnborough's modern version of the B.E.1 originally designed by Geoffrey de Havilland. Major R. H. Mayo, who had succeeded the late Ted Busk as head of the RAF Physics Department, said: 'The B.E.2c was evolved by Busk from the B.E.2a by shifting the lower plane back 2 ft and altering the type and setting of the tailplane. These modifications made the machine longitudinally stable. At the same time the warping method of lateral control was abandoned in favour of the wing flap [aileron] method,

and the wings were set at much larger dihedral. The final modification to convert the B.E.2a to B.E.2c was the introduction of a fin in front of the rudder.

'The B.E.2a had been quite unstable laterally despite the self-warping tendency of the wing hit by a gust to decrease incidence and increase the other. The resultant waggling of the stick, although checked by powerful springs, was a great inconvenience if the weather was bumpy, but lateral control was powerful and effective at low speeds though normally too heavy to operate comfortably because one had to work against the springs.

'Behaviour of the experimental B.E.2c was very convincing. Apart from the fact that it was quite stable longitudinally, the lateral control, though now less powerful, was much more convenient for the pilot, but a new

The B.E.2c was a development of the B.E.2a, but had cowled Renault engine and a vertical fin. It retained cable bracing. (*A. P. Thurston.*)

trouble was introduced by a distinct tendency to turn of its own accord if the rudder was left free. When flight-tested by various representatives of the Royal Flying Corps (RFC) there was considerable discussion as to whether the machine was sufficiently controllable when gliding in to land, and whether there was enough elevator for the pilot to reduce speed to actual stalling as he landed. The matter was somewhat complicated because Busk practically never landed well, no matter what machine he was flying, so that his opinion on this matter was somewhat discredited by other pilots. The general consensus was that neither lateral nor longitudinal control was as effective as it should be, but sufficiently good for the machine to go into production.

'The introduction of the stabilized machine caused heated controversy among pilots, complicated by the fact that the increased weight of the B.E.2c reduced its performance, especially climb, below that of the B.E.2a, but the principal criticism among those acquainted with the unstable B.E.2a remained that of the less effective control of the new machine. I am

convinced the idea was fallacious. Pilots used to the necessity of controlling a machine in bumps could not appreciate the value of one which automatically righted itself both longitudinally and laterally, and of course more control movement had to be made to overcome the stability resulting in bigger load on the pilot's arm.'

As Commanding Officer of the RFC in France, Brig-General Henderson, on the expert technical advice of O'Gorman, could not reasonably have done other than decide that the B.E.2c, backed by the tremendous design and research facilities of the Royal Aircraft Factory, must be standardized in one tremendous effort to obtain in the shortest time the greatest number of aeroplanes. Because the advantages of aerial warfare were so little understood, parsimonious pre-war government policy had resulted in the RFC being so inadequately equipped when war broke out that it failed to be of vital value, for it could not strike a massive bombing blow. Conception of the prime importance of aerial reconnaissance was soundly dictated by the prevailing military outlook on scouting, based on Boer War practice, but now the necessity of artillery air spotting had become paramount because both sides were beleaguered so immovably in their trenches that the battle must depend on long-range pounding by big guns, of which there were still only limited numbers though munition production was intensifying. To match the envisaged future fire power there would have to be not only numerically comparable aeroplanes, but also considerable reserves to overcome devastating wastage both at the Front and during pilot training.

Standardization clearly facilitated supply and repair, so Farnborough

With the introduction of the RAF 1a engine a simple V-undercarriage was used for the B.E.2c, and lenticular-section Rafwires replaced cable bracing. The first Bristol-built B.E.2c is seen at Filton. This example had downward exhausts.

technicians had long established interchangeability from type to type for many individual fittings, struts, ribs, wires: thus the wings of the B.E.2c, complete with fittings, struts, and rigging, were used as outer bays for the F.E.2a and F.E.2b pushers; while the new, more powerful twelve-cylinder RAF 4a engine employed standard parts of the established RAF 1a, including the same cylinders.

To make B.E.2c constructional techniques indisputably clear to those with no previous experience of the accuracy and perfection required, the Farnborough team, directed by Fred M. Green, the chief engineer, 'made elaborate detailed dimensioned drawings, marked with every permitted kind and degree of variation – as many as 400 drawings to a single aeroplane instead of the usual score. With the help of these drawings all kinds of firms – organ-builders, makers of furniture, or pianos, or gramophones, or motor-cars – could be turned to aeroplane manufacture. In the course of two years some half-million drawings were issued to various firms; and those to whom the whole business of engineering was strange were successfully initiated into one of the most delicate and difficult branches. In addition, their managers and foremen were put through an intensive course of instruction at the Royal Aircraft Factory.'*

War Office Department M.A.2, dealing with equipment, and M.A.3 as contractual branch, headed by the tall and dignified Arthur E. Turner, had to expand rapidly before contracts could be placed, but eventually fixed a price of £1,072 10s for a B.E.2c airframe bare of engine, instruments, or equipment. An engine cost £522 10s. Of the twenty-two major contractors currently building this machine, all except seven had some aircraft experience, but of extensive production they knew nothing. Construction of the prototype B.E.2c had presented no great problem to the skilled craftsmen of the Royal Aircraft Factory, but the task was far harder for newcomers because the whole conception had to be studied as a novelty and then scheduled in detail. Even sub-contracting and the necessity of ordering a series of fittings in considerable numbers were new, so the problem of co-ordinating completion at the correct moment seemed almost insurmountable to a generation which had seen little mass-construction. Inevitably there was delay. Though early production B.E.2cs had appeared in the latter part of 1914, none had yet gone to France.

The first production sequences followed the prototype closely, using the same skid undercarriage and wing cable bracing, and were fitted with Renault engines bought from France – but the next version had the 90 hp RAF 1a engine, and employed a clean V-undercarriage of steel tube streamlined with wooden fairings, using a cross-axle sprung with a 40 ft skein of $\frac{3}{8}$-in rubber shock cord. To reduce aerodynamic drag all wing bracing cables were replaced by lenticular section Rafwires of swaged steel. Still later variants had RAF 14 wing section instead of RAF 6. To facilitate inspection, fuselages had the fabric detachably laced using boot-type hooks as devised by Cody for airship nacelles. Even risk of carbon

**The War in the Air*, Sir Walter Raleigh.

monoxide poisoning had been considered, so the exhaust from each bank of cylinders was led over the top centre-section in streamlined stack pipes, though some B.E.s for the Royal Naval Air Service (RNAS) had long pipes running horizontally along the fuselage to just abaft the rear cockpit. In theory the B.E. was not intended to carry guns because the observer was in a bad fighting position beneath the centre-section, with only limited field of fire between struts and wires outboard of the propeller disc. Should it prove necessary to safeguard these machines while on reconnaissance, the Vickers pusher with its vicious field of fire from its nose-mounted gun was scheduled as escort, together with the new F.E.2a and the odd Martinsyde or Bristol Scout fitted with a Lewis gun on the centre-section, though it was assumed that hostile anti-aircraft fire would afford greater risk than attack by enemy fighters.

Great though the problems were of organizing adequate airframe production, they were insignificant compared with securing sufficient engines. George Holt Thomas – that prominent aircraft industrialist whose appearance was not unlike the King's – had foreseen this long before the war, and therefore obtained a manufacturing licence from the French Gnome company. His production of the 100 hp Monosoupape was extensively planned but constantly held up by magneto shortages because the world supplier had been the German Bosch and only a few were obtainable through neutral countries. The sole British magneto was a technically obsolete product made by the one specialist company for road vehicles. Two others were now urged to undertake magneto production, but tremendous delay occurred in securing such essentials as copper wire, magnets, oiled-silk, and hard rubber insulating material. A limited supply of vehicle magnetos was available from the USA but proved unreliable for aircraft engines.

The Monosoupape Bristol Scout D was the RNAS version and one of them, flown by Flight Lieut H. F. Towler, made the first deck take-off from a British ship. (*R. E. Nicoll.*)

The Martinsyde S.1 was used by Nos. 1, 4, 5 and 6 Squadrons early in 1915. *(Courtesy J. M. Bruce.)*

It had been Holt Thomas's intention to produce the French Le Rhône as it had been commended by Capt J. D. B. Fulton, head of the Aeronautical Inspection Department, after testing it in France early in 1914, but although both men urged the War Office to obtain a manufacturing licence they encountered strong counter opinion that only one type of rotary should be standardized to simplify provisioning. All too late for the pressing need, Holt Thomas succeeded in securing British rights, and was now in process of tooling and jigging, though many months must pass before there could be reasonable production flow. To meet the overwhelming demand, recourse had to be made to the French who co-operatively allocated a few Gnomes and Le Rhônes despite vital requirements for their own Air Services.

Urgent action had been taken to ensure that British motor-car manufacturers at least built the RAF 1a in numbers matching proposed production of the B.E.2c. Production would have started sooner but for a bad set-back the previous November through destruction of the first experimental engine in the prototype B.E.2c which caught fire when being flown by Farnborough's star scientist-pilot, Ted Busk, the ensuing crash destroying aeroplane and engine and killing the pilot.

O'Gorman and Green had long foreseen the inescapable demand for more and more power; a belief equally held by the iron-willed Commodore Murray Sueter and his Admiralty technicians. On the outbreak of war the Air Department of the Navy, dissatisfied at delay in developing a 200 hp Sunbeam they had commissioned Louis Coatalen to design, placed a contract with Rolls-Royce for an engine of 250 hp. Concurrently the Napier company began a similar high-powered engine to War Office requirements. 'The experts of the Royal Aircraft Factory gave the two firms all possible data, and the existing drawings of the 250 hp RAF 3

water-cooled engine were handed to them. Napiers closely followed this design, but that remarkable genius, Henry Royce, proceeded *de novo*,' recorded the Farnborough historiographers S. Child and C. F. Caunter.

At the next meeting of Rolls-Royce shareholders the chairman said: 'After a few weeks of the war we were approached by the British Government to manufacture engines such as few could attempt, and the firm are engaged on it almost exclusively. This superior class of work promises to suit our organization well and afford better profits, so we hope to gain such a reputation as to justify continuing it independently of war time, for the demand will always exist as for our motor chassis.

'It must be appreciated that departures of this character cannot be effected at short notice. Designs, experiments, drawings, patterns, and tools have each in turn to be made before anything can be produced, and time is absorbed in attaining sufficient momentum. Three months may have gone with little benefit from such new sources, but every effort is being made to make good the remainder. When war broke out the company's trade became largely diminished, but commenced to recover within a few weeks, and already production of motor chassis has re-attained half the maximum hitherto reached – a remarkable achievement. As our usual trade of manufacturing motor-car chassis shows such buoyancy, and we shortly have a second string in the form of special engines, we may eventually do as well as ever.'

3

Before the war the Government had considered it safe to keep the British aeroplane and aero-engine Trade ticking over with minimal orders, believing that in emergency the strong French aircraft industry, where there were real factories rather than scattered collections of sheds, could satisfy all needs. Sir Walter Raleigh, in the opening volume of *The War in the Air*, describes what ensued: 'In October 1914 a Flying Corps officer was sent to Paris to organize a department to deal with purchase of French aircraft supplies. The Paris office, which dealt through the French Ministry of War, became known as the British Aviation Supplies Department, and in December a representative joined the Department to watch the interests of the Naval Air Service and place orders on behalf of the Admiralty Air Department. The Paris office did not work smoothly. From the outset the War Office and Admiralty representatives were, by nature of their different allegiance, in competition. Each was there to get all he could for his own Service, and the consequent friction led to disappointments which, because many of the high performance aeroplanes used by the RFC were French, had repercussion in the field. The result was that Maj-Gen Trenchard* found it essential to make many personal visits to the French firms, accompanied by the Flying Corps representative in Paris. French manufacturers were in no real position to meet British demands, but were themselves in need of essential materials which we

*At that time Lieut-Colonel at Farnborough building up the RFC.

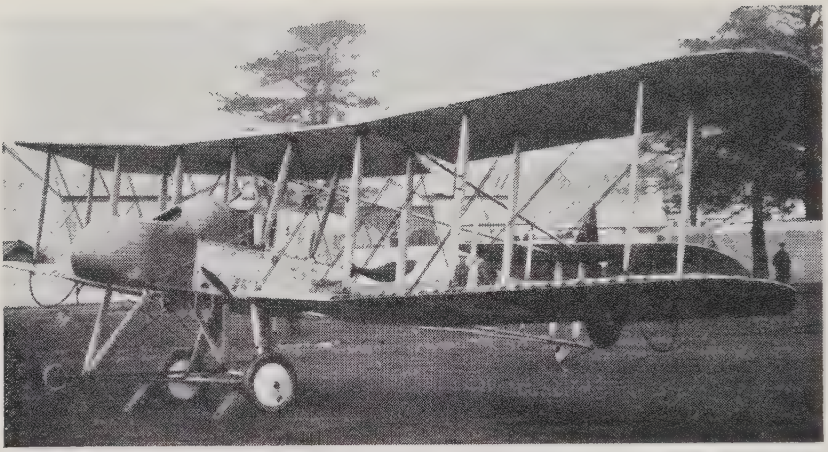
could supply, such as steel in the raw and treated, aeroplane cable, ball-bearings, and Davis guns. The matter therefore became one of bargaining, or, to use a more polite word, of reciprocity.'

In their bulldog way British aeronautical companies were steadily overcoming difficulties and expanding to meet the envisaged demands. Their outlook was ably expressed by that great automobile engineer and aeronautical theorist, F. W. Lanchester, who in the 1914 Christmas issue of *Engineering* had written: 'The supremacy of British aircraft can only be maintained by the adoption of a thoroughly progressive constructional policy, guided constantly by the most recent scientific discovery in research and by utilizing to the full information and experience gained in the Services. The day is past when technique or craftsmanship can be permanently bottled, and the trade or art in question monopolized by any single nation, as was at one time the case. Under present-day conditions the lead can only be obtained and held by mobility and progress in which the motive power is a combination of brains, energy, and material resources.'

The prototype D.H.1 with air-brake winglets projecting from the nacelle. Geoffrey de Havilland is seen in the rear cockpit. (*Imperial War Museum.*)

Typical of such progressive outlook was the Aircraft Manufacturing Company which for some months in the previous autumn had been constructing a pusher fighter designed by Geoffrey de Havilland on the basis of the F.E. developed at the Royal Aircraft Factory from his privately built and ultimately successful second biplane. Instead of receiving the 100 hp Green for which it had been redesigned, de H. was brusquely told in December that all were diverted to the twelve F.E.2a escort fighters at that time nearing completion at Farnborough. Instead he was offered a 70 hp Renault, and as it was just sufficiently powerful for experimental flights, reluctantly fitted this heavy engine to the D.H.1 nacelle.

At the beginning of February *Flight* reported: 'A week or so ago considerable interest was aroused by the appearance of the new gun-carrying biplane designed by Mr G. de Havilland and built by the Aircraft Co. The



The prototype F.E.2a with 100 hp Green engine. The flap-type centre-section air-brake is visible. (*Imperial War Museum.*)

first time out Mr de Havilland demonstrated his faith by taking it to nearly 1,000 ft, and later it was flown by Mr Birchenough, who gave an excellent report of its behaviour. On Saturday last Mr de Havilland was again putting it through its paces, including steeply banked left and right turns. On one occasion he covered two circuits of the aerodrome with hands above his head to show that stability was such that she only needed steering. The long rear edge of the wing-tips and the dihedral give a very graceful appearance when in the air, and for a pusher she certainly seems very fast. I shall not be surprised if more of this type make appearance at regular intervals, are tested, and disappear gracefully beyond the Welsh Harp in the direction of, well, say Staines.'

The same issue also recorded that: 'The *habitués* at Hendon were treated to a fine display of flying by Mr Frank Goodden, chief pilot of the Government Factory, who arrived from Farnborough on a new B.E.2c accompanied by his colleague Mr H. R. Harker. A peculiar crackling noise coming from the direction of the Welsh Harp attracted everyone's attention. Soon a biplane emerged from the haze, and the rounded wing-tips and narrow body immediately made it recognizable as a B.E.2c. Coming over the sheds at what seemed a terrific pace the machine commenced a series of left and right hand turns, switchbacks, and slow flying before landing by No. 1 Pylon. Those who knew Goodden's style were pretty certain who was the man at the wheel.

'Goodden was very enthusiastic, and as he has flown several different types and has good knowledge of construction and design, his opinion is worth listening to. He has attempted everything he can think of to test the stability, such as looping and tail-sliding, and she behaved perfectly. He has even tried letting go control when in a vertical bank whilst flying in a straight line: sliding down gently, she gradually straightened out,

slightly overshot horizontal, levelled, and proceeded as if nothing had happened. Inherent stability is so perfect, Goodden says, that when the desired altitude is reached you could snug down in the cockpit and read a book, for unless you want to go in any particular direction the 'bus needs no attention. Her maximum speed with two up and full load is over 80 mph, which is distinctly good for an engine of 70 hp, and landing is well under 40 mph. As a flying machine the B.E.2c is one of which any designer may be proud.'

Good though this officially produced aeroplane appeared to be, the new D.H.1 seemed equally able. Gleefully the editor of *The Aeroplane*, always ready to push the Trade at the expense of the Factory even though de Havilland had designed the prototype B.E., wrote: 'The fact that we have produced in the D.H.1 a machine with all the advertised qualities of the B.E.2c, plus the ability to carry a machine-gun and climb more quickly in spite of the added weight, is a feather in the cap of the Aircraft Manufacturing Co. Even more to the credit of the firm and its designer is the fact that the machine can be produced without delays arising from specifying almost unobtainable fittings. Everything is of the simplest. There are practically no special stampings, forgings, pressings or other irritating details which are breaking the hearts of the unfortunate firms who have been persuaded into the aeroplane industry by orders for B.E.2cs – and withal the D.H. is a better aeroplane.'

Although the new impressively huge F.E.2a pusher, fitted with the 100 hp Green which de Havilland wanted, was being currently tested at Farnborough with apparent success, Holt Thomas was confident that his D.H.1 merited orders because its structure was cheaper, and despite 30 hp

A standard production D.H.1 reveals forward pointing exhaust. (*D. F. Woodford.*)

less than the F.E.2a it was 7 or 8 mph faster. However, the Government-sponsored machine carried nearly three times the load in guns or bombs, and more than half as much fuel again, so it had great potential value. Both types were visibly underpowered. Knowing O'Gorman intended to fit later F.E.2s with a Beardmore of 120 hp recently developed from the Austro-Daimler, Holt Thomas made successful representation to secure similar engines for a strengthened version of de Havilland's machine – which like the F.E. now dispensed with the rotatable air-brakes each had featured to eliminate landing float, but which resulted in unacceptable buffeting due to proximity of the propeller.

The D.H.1 was used for advanced flying training, with inevitable high wastage from bad landings. Most pilots wrecked at least one aeroplane, and often five or six. (*D. F. Woodford.*)

Already Geoffrey de Havilland had been seeking the trend of future requirements from Lieut-Col Frederick Sykes – until recently Officer Commanding the RFC but now gazetted General Staff Officer on re-organization of the Service into Wings under separate commanding officers, with two, three, or in special cases four squadrons to each Wing. Ever since the Military Aircraft Trials on Salisbury Plain in August 1912 they had remained in touch, and in *Sky Fever* de Havilland wrote: 'I liked him, and we became good friends. He was not at all like the typical soldier or airman in manner or appearance, but far more like a scholar or university don. Of slim build, with soft voice and great charm of manner, he was an almost exact opposite of his successor, the great "Boom" Trenchard. . . . I felt deeply touched when I heard from Lady Sykes after her husband's death that he expressed a wish that I should scatter his ashes from the air over Salisbury Plain where he lived, and where we had taken off for our memorable record-breaking high flight in the B.E. more than forty years before. And this I did.'

A D.H.1 in flight. Absence of slipstream and remote engine noise, coupled with exceptional view of the countryside, made this the most pleasant form of flying if one were not at war. (*Flight Photo.*)

Although Sykes's penetrating and analytical mind led to uneasy relationship with many colleagues, none could better advise de Havilland on developments in the strategy and tactics of air operations. His conviction that a single-seat fighter aircraft would prove essential to prevent penetration of hostile reconnaissance machines over the Allied lines led de Havilland to put on paper, well before the D.H.1 had flown, a single-seat pusher resembling a scaled-down version of the two-seater. Major Sefton Brancker and Major Geoffrey Salmond, of the Military Aeronautics Directorate, were attracted by the aggressive potential of this neat 28 ft span, 100 hp fighter, and promised production orders if it proved successful. Indeed, they went further and instructed O'Gorman that the Royal Aircraft Factory must design a similar machine in case de Havilland's failed to meet expectation.

Pleased with the expanding vista for his great company, George Holt Thomas wrote on 11 February from his London office at 47 Victoria Street to his dedicated designer-pilot: 'Dear Mr de Havilland – In reference to our conversation and the question of a longer Agreement, I write to say that I shall now be willing to come to an arrangement with you by which the terms of our Agreement are generally left intact, but you now continue in your present capacity for a period of five years from the 1st February, we guaranteeing you a minimum payment of £1,200 per annum, i.e. the salary under your Agreement will still remain the same, but we will pay you salary and a minimum guarantee on royalties of £1,200 per annum.

'I think that it would be more convenient and fairer to us both if we arrange the royalties on the orders received i.e. presuming we receive an order for fifty of your existing machines at once, I propose that the royalties payable shall be £50 per machine for the first twenty-five of the order and £25 per machine for the second twenty-five of the order, such royalties to be due on each machine passing its test. I think that this

would be a better arrangement as deliveries of machines are affected by many circumstances, and it is difficult to bring them within any particular period e.g. the delay in the first machine is largely due to the fact that the War Office commandeered your services.

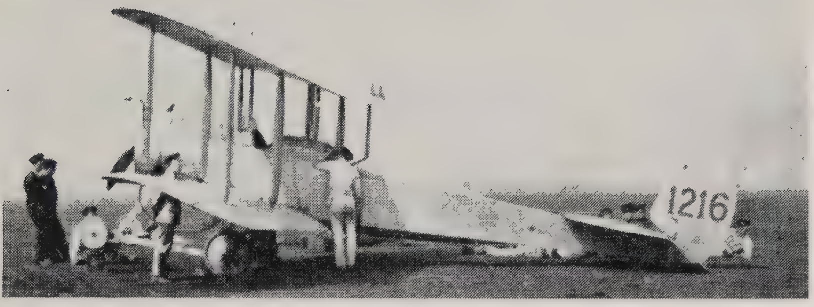
'I am sorry to hear you are ill, but hope that you will soon be all right again. If it is influenza, do not risk anything by coming out too soon. Yours truly G. Holt Thomas.'

A pencil annotation by the recipient – the least mercenary of men – calculated that royalties alone might well amount to what seemed the enormous sum of £2,500 during the next year, to which would be added his basic salary of £600. In fact, because his engagement had been extended beyond 'one year certain' he was likely to become quite a rich man.

That same day, Holt Thomas wrote a reprimand to C. G. Grey, and expressed an attitude widely held by other leading aircraft manufacturers: 'Sir, – In your article describing Mr de Havilland's new machine designed for the Aircraft Manufacturing Co Ltd you severely criticise the Royal Aircraft Factory – this I think is hardly fair, as although the machine is due to Mr de Havilland, I am sure he will be the first to acknowledge his indebtedness to information obtained from the experimental work carried out by the National Physical Laboratory and the Royal Aircraft Factory.'

Those who knew C. G. Grey well were convinced that his increasing attacks on the Royal Aircraft Factory were dictated by instinctive distrust of bureaucracy and whole-hearted belief that better aircraft would emerge in free competition if manufacturing was left in private hands. Yet it was poor judgement to use his journal increasingly against that devoted group of engineers and scientists working under the inspiring leadership of O'Gorman, for they had set standards of research and construction unsurpassed anywhere in the world. A coterie of politicians saw that Grey was playing into their hands.

When the well known aeronautical journalist, Clarence Winchester, praised Farnborough products by saying in *The Times Engineering Supplement*: 'During the past year the B.E., by far the fastest stable biplane for its power, was adopted in large quantities by the Army, and ordered from ten or a dozen large engineering firms, while many more have been adopted by the Navy,' it inevitably added fuel to Grey's fire. 'Here we have a dangerously misleading statement,' he thundered in the next issue of *The Aeroplane*. 'So far, thanks to the continual alterations in drawings, due to the futility, vacuity, and general ineptitude of the Royal Aircraft Factory and its mismanagement, very few indeed of the "large quantities" of "stable biplanes" ordered in 1914 have yet been adopted, because the vast majority have not yet been made. Further the B.E.2c is a B.E. only in name. In aerodynamic design and constructional detail it is utterly different from Mr de Havilland's successful experiment of the B.E.2 of early 1912. It flies miles an hour slower and climbs barely half as fast as that three year old design – which may, or may not, be comforting to young officers who are up against fast flying, quick climbing German



The Bristol T.B.8s ordered by the War Office were diverted to No. 1 Squadron RNAS and a detached Flight of four machines was sent to Newcastle upon Tyne for coastal reconnaissance. In August 1915 24 training T.B.8s were built at British and Colonial's Brislington factory.

biplanes. . . . Fastest *for its power* is no consolation in war, whatever it may be in an academic argument,' he added, forgetting it was the yardstick he recently used in describing the industry's aircraft, and concluded: 'Incidentally could anything be more grotesque than the attempt to standardize and order in large quantities a machine which admits in its own official title that it is only an experiment – for B.E. stands for Blériot Experimental?'

The Dutch-born aviation manager of Sir W. G. Armstrong Whitworth & Co Ltd, Frederick Koolhoven, widely known as 'Kully', was equally critical of the B.E.2c, though to different purpose. As a company private venture he had built new wings for one of the somewhat B.E.-like Bristol T.B.8s of the Naval Flight at Gosforth, alleging they would improve performance – but they did not. So he turned from the Admiralty to the War Office with argument that he found the B.E.2cs which his firm built were too complicated for easy production, and he could revamp the design,

Only a 50 hp Gnome was available for Koolhoven's first flight tests with his F.K.1 which originally had deficiencies in all three controls and was longitudinally unstable until a tailplane was fitted. (*Courtesy J. M. Bruce.*)

using the same metal fittings but increasing the span by 3 ft to give a wing area of 442 sq ft against the 371 sq ft of the B.E.2c, as well as lengthening the fuselage 2 ft, yet the all-up weight would be less. His drawings showed a biplane which at first glance might well be mistaken for its rival, though distinguished by a tall balanced rudder, slightly deeper fuselage, and a distinctive single-skid undercarriage inspired by the Avro 504, but it retained the unsatisfactory seating arrangement of the B.E.2c, with observer in front. So convincing was Kully's salesmanship that the Aeronautics Directorate were inclined to believe constructional speed-up could result, and accordingly his company was given a contract to proceed. They at least had assurance that he had helped design aeroplanes as assistant to the great Béchereau at Deperdussin's in France, and recently had built a single-seat biplane, the F.K.1, which Major Chris Draper later described as 'delightful to fly, with a stalling speed of 30 mph'; but it was crude compared with the Sopwith Tabloid Scout.

4

One of the duties earmarked for the B.E.2c was Home Defence. On the night of Tuesday, 19 January, the urgency of having night-flying aeroplanes for this purpose became a priority – for hidden above the moonlit overcast, exactly as people had long feared, the first Zeppelins stole to England, dropped their bombs, and killed two elderly people. An excited Press trumpeted the news as though this was invasion. There was such outcry against bringing war home to civilians, instead of leaving it to the paid soldier, that a German newspaper almost anxiously retorted: 'England has no right to be indignant, as her flying machines and ships in broad daylight attacked open towns such as Freiburg, Dar-es-Salaam, and Swakopemund.'

Security regulations were tightened. Special constables were enrolled to ensure that no chink of gaslight showed through drawn curtains. Boy Scouts would warn if a raid was imminent and afterwards sound all clear on their bugles. The *Daily Mail* of 28 January ran a heading: 'The safest place in a Zeppelin Raid,' commending with all seriousness a bomb hole or house that had been hit as 'the chances are 50,000:1 against a Zeppelin bomb being able to hit twice in the same place'. During the next few days snow fell, and everywhere lay under a white mantle that promised respite while it lasted. In London people flocked to the theatre, or to the pantomime where Ninette de Valois was the dancing success of the season in *Jack and the Beanstalk*, or to hear a clever little artist at the Garrick called Yvonne Arnaud whose personality was described as 'so piquant that she could make a success of almost any musical play'.

But the end of February brought the imminence of aerial attack dramatically closer – for two German officers were landed at Lowestoft from the smack *New Boy* which had found them 40 miles off Cromer clinging to a wing of their wrecked bombing aeroplane, scarcely able to move after surviving snowstorms and icy water for a day and a half. Horror that here in this country were the very men who had been sent to bomb and kill was

typically mingled with admiration at the endurance and courage of these 25-year-olds who so obviously expected to be lynched on being taken aboard and were astonished at being well treated.

With the next Zeppelin raid on Norfolk the worst fears seemed confirmed. Had another raid immediately followed there might have been panic; but spirits temporarily lifted two days later when a Naval force under Vice-Admiral Beatty intercepted four German battle cruisers, and the *Blücher*, pride of the German Navy, was sunk. A jubilant populace gazed wide-eyed at newspaper photographs of her heeling before the last plunge with hundreds of helpless sailors crowding like flies over the whole length of her topsides. Nevertheless such was the increasing dread of Zeppelins that Charles Wakefield, head of the company manufacturing Castrol lubricant on which rotary engines depended, was prompted to offer £500 to the first person to bring down a Zeppelin on the soil of the United Kingdom. Other magnates followed suit until there was a big sum in aggregate. Parliament was quick to declare it wrong in principle to offer money to soldiers or sailors doing no more than their national duty, and presently drafted legislation to prevent such awards.

Pre-war German publicity proved a good psychological weapon against British civilians, whose worst fears were realized when Zeppelins such as the L.9 began their attacks and initially seemed undefeatable.

There was little belief that the war would soon be over and more reasoned assessments began to appear, for it was essential to forecast the Government's requirements for men, material, food, and money. From the begining Germany had an army about a tenth greater than the Allies. To match it was paramount. The last German census showed a population of 65 million, to which must be added 50 million in her allies Austria and Hungary. Assuming 10 per cent were physically fit to bear arms, this gave a fighting force of at least 11 million – rendered even more effective because every man in the German Army had undergone tough compulsory

military training which ensured higher standards of health and strength than the average raw recruit entering British ranks. Even if estimates of German casualties were trebled to a hypothetical 3 million, it was on the cards that two-thirds would become fit for service again. 'At that rate,' declared a statistician, 'the enemy will not for many months feel any serious consequences from diminution of its forces. We and our Allies could – for though we may bring many millions into the field, time is essential to train them. The enemy has the advantage in efficiency, and months and years alone can alter it.'

Although maximum food prices had been imposed in Great Britain, together with government control of corn, it was estimated there would be no lack for eighteen months at least, particularly as imported foodstuffs were largely luxuries. On the score of unprofitability, corn had not been quantity-produced in pre-war England but sufficient could be grown to satisfy moderate demand, and meat production could be similarly increased. Economists realized prices would rise, luxury fade, and rigid economy oust profusion; but people would not starve yet awhile.

'The vital question is Germany's future in the battle-field,' wrote a military expert. 'In six months he has overrun Belgium, advanced 50 miles into France, and a little further into Russia, but Naval success lies to-day with the Allied fleets and will probably remain so in future.

'The exigencies of war make it impossible to detail sufficient German troops to drive the Russians back on Moscow and Petrograd [now Leningrad]; but in any case the vast expanse of Russia, the sparse population, and the thin cultivation of the land over which a victorious army must pass, would render success unduly expensive. Any German advance must be in France if at all. In the spring Germany will again move; whether backward or forward is in the hands of fate, but with the disadvantage of fighting huge armies of fresh men brought by the Allies from all corners of the earth. Final success in the original objective is impossible, but one has yet to see whether the limited objective so dear to Clausewitz will not ultimately be attained.

'One finds that the advent of the aeroplane far from having speeded action has retarded it to astounding degree. It was once possible to deploy troops in movements having fair chance of avoiding detection until too late for reply. To-day all is different. The aerial scout, working in close contact with the cavalry scout in the early stages of conflict, reveals all of importance. Nothing is concealed. War begins to approximate to chess. Where manoeuvre on a grand scale used to be conceived and arranged in the course of a day, now a week may be absorbed preparing the same operation. Long, slow, sweeping, apparently indecisive moves have to be made day after day, while the real objective is concealed. To-day, when two armies of equal intelligence match themselves against each other, tactics become one long monotony with not one fifth of the speed of old – all because of aircraft, even though they are still in an experimental stage.

'If we assume Germany and Austria have men, materials, food and

money to last until the summer of 1916, she will lack neither determination nor skill to fight until that time. In these two years of war there is likely to be only as much operation as would fill six months of past wars. This slowness of action is entirely due to aircraft – the new invention which was either to accelerate war or cause all wars to cease; which can never be.'

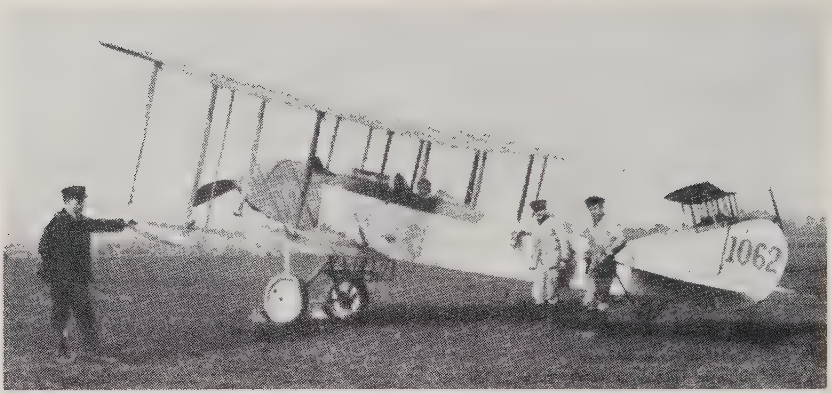
To turn war into the kind of gamble loved by the British, the *Daily Mail* printed maps of the Western Front by the million, putting them on sale, complete with packets of miniature flags on pins, 'Price 6d. Order at once', so that the daily gains of either side could be marked up like a race. It helped sublimate such ominous signs as Admiralty reaction to U-boats when their Lordships ordered the *Lusitania* to steer for Liverpool under false colours of neutrality, flying America's Stars and Stripes. Germany was quick to seize advantage of mass Press publicity by leaking news through neutral countries that she would intensify submarine warfare to her utmost. 'Piracy' was the muttered epithet at such flouting of Britain's command of the seas – but it was all too evident that France and England were under siege, and there was deep indignation, both in Great Britain and the USA, that Germany had no compunction in sinking non-combatant shipping whose brave crews were bringing vitally needed subsistence to our island. Nevertheless, British warships these many months had been stopping and searching all neutral vessels.

With renewed relief Britishers read in their newspapers a few days later that Britain's newest battleship *Queen Elizabeth* had bombarded the Turks in the Dardanelles – for this Ottoman alliance with Germany and Austro-Hungary was a threat to the life-line of Allied food supply shipped through the British capitalized Suez Canal. Presently it transpired that this offensive was at 40-year-old Winston Churchill's instigation.

5

The British aircraft industry, like that of Germany, was making good use of the war's stalemate. Construction of several new designs was under weigh now that production planning had well advanced.

Towards the end of May the Hendonites saw the celebrated Harry Hawker arrive with what seemed a new type of Sopwith two-seater, which he displayed round the pylons before landing. In fact it was the landplane development of the Type 807 seaplane designed for the 1914 Round Britain contest and later ordered by the Admiralty in a version employing folding wings based on Short Bros mechanism for which Sopwith paid a royalty of £15 per machine. Now fitted with a V-undercarriage, the new development had become an equal-span two-bay biplane, but retained the distinctive nose location of the observer because of the superb upward view beyond the centre-section, and had the typical 'fish-mouth' appearance introduced by the Tabloid to give flowing contour to the cowling as the result of using a front mounting plate for the 100 hp Gnome. Intended for anti-Zeppelin patrol, armament could be either a rifle firing Hales grenades or a Mauser firing incendiary ammunition,



Two Sopwith Spinning Jennies ready for test at Hendon. The crew had less restricted visibility than with any other tractor of that time. Sigrist made a single-bay version of this machine. (*Courtesy J. M. Bruce.*)

and there were external racks beneath the fuselage abaft the undercarriage for light incendiary bombs.

Home Defence was the Navy's task and its pilots soon discovered that when fully loaded at aft C.G. this unstaggered biplane was prone to spin – but because of the long low fin, originated and used in even more exaggerated form by Horace Short for his designs, recovery, as demonstrated by Lieut J. C. Brooke, was immediate on pushing the stick forward with centralized rudder. Hawker, caught napping for once, similarly investigated the manoeuvre and confirmed there was no real danger, but the lighthearted name 'Spinning Jenny' stuck to the machine.

Back at Kingston, Tom Sopwith's great factotum, the dour determined Fred Sigrist, as a result of discussion with Hawker on the possible form of a replacement two-seater with enhanced performance and safer characteristics, modelled a new fuselage on the 807 using a bigger fin having a rounded nose of bent tube, and stiffened the main wing spars in order to employ a single bay with outward-raking struts, shortening the lower wing proportionately. To reduce bending moments of the upper wing he used steel centre-section struts steeply sloping from the top longeron to a point well out in the spar bay, and then braced the centre-line juncture of port and starboard spars within inverted V-struts arranged like a trestle, resulting in a widespread transverse W. The machine had been growing slowly in a corner of the old Kingston Skating Rink, for Sigrist was preoccupied with production matters, and it would be another month or more before the framework was ready for covering. Meanwhile it was jocularly referred to by the workmen as 'Sigrist's Bus'.

Design staff had been considerably increased, and the draughtsmen were housed in a large top room of the new works extension in Canbury Park Road, adjoining the Skating Rink. Tom Sopwith was still the lively supervisor of design, but inevitably was becoming more and more engros-

sed with general management. To relieve him of accountancy tasks a youngster called Frank Spriggs had been engaged as costing book-keeper, and for better control of technical matters the leading draughtsman, Herbert Smith, was appointed chief designer, with R. J. Ashfield, who had designed pre-war Sopwiths from the Bat-boat onwards, in the rôle of project engineer.

Fair-haired, with steel-blue eyes, Smith was an up and coming young man who got on well with Sigrist, quickly assimilating his forcibly expressed ideas on the type of detail design which suited their skills and production facilities. He was an engineering diplomate of Bradfield Technical College, and after three years practical workshop experience and a further year of engineering drawing he had joined the British and Colonial Aeroplane Co in 1913 under the histrionic Henri Coanda, but transferred to Sopwith Aviation in March 1914 as a draughtsman. He now had a score of men on stressing and drawing. Sid Burgoyne, son of the famous boat-builder at Kingston, was the specialist in float design; Bob Noorduyn, Freelove, Lucking, Williams, Matthews, Don Jardin, and John Bewsher were key draughtsmen, and young Shaw was office boy. B. D. Thomas had recently sailed to the USA where he joined the Curtiss Aeroplane Company to design a trainer which closely followed the structure of the Admiralty Type 137 seaplane he had draughted in 1914. R. J. Alston, designer of the folding-wing seaplane, had been drowned when it turned over, and Ridley and Parr had joined the RFC. 'The pace had become so hot,' said Ashfield, 'that I was relieved of office supervision and given a small selected staff and located in the old Rink once more, which now was the Experimental department under Len Pollard. Our job was to carry initial concepts to a logical conclusion. The first aircraft of note designed

The small Sopwith drawing office, with R. J. Ashfield standing centre, Bob Noorduyn right, Herbert Smith next to him, and Frank Cowlin last but one in that row.

by this office was the Pup, which was originally built round a 50 hp Gnome and had warping wings.'

This was Hawker's single-seat 'Runabout' known at that time as the S1.T.B.P, revealing Harry Hawker's interpretation of Sykes's requirement for a fighter with a Lewis gun on the centre-section, and powered temporarily with the old Gnome which Sopwith had originally fitted to his Burgess-Wright biplane. Its typical Sopwith structure had been tailored with growing experience into even prettier configuration than the Tabloid on which it was based, arising partly from Hawker's appreciation that the predominating mass of engine, gun, fuel, and pilot should be concentrated to give minimum inertia and the C.G. well forward. The engine was therefore installed in similar manner to Barnwell's popular Bristol Scout, cantilevered from a single rear mounting in the manner first envisaged by Horace Short, and adopted similar annular cowling faired gradually into the rectangular fuselage. The pilot was located even further forward than in the Tabloid, and could only gain the cockpit by sliding between the rear centre-section struts. Firm stagger offered good downward view and brought the C.G. still further forward relative to the lower wing. Because warping was adopted for constructional simplicity, the rear spar was made shorter than the front to reduce tip-bending under torsion, resulting in reversed tip rake compared with previous Sopwiths, so the tailplane was contoured to match, and the fin had the same emphatically rounded nose as Sigrist's Bus. Both aeroplanes were given the relatively long fuselage lever arm proved so efficacious for stability and easy control in the Avro 504. Chalked full-scale on the experimental department's floor, the S1.T.B.P. presently began to take shape.

Frank Cowlin, the original Sopwith stressman, had left because Harris Booth, who preceded him at school and Cambridge in studying mathematics and engineering, offered him the job of technical supervisor at the Royal Naval Air Station of Eastchurch – where the pre-war Royal Aero Club flying ground had been commandeered, though still used by Shorts for testing.

'The main part of my work,' recounted Cowlin, 'was development of the airspeed indicator which Alec Ogilvie, that early owner of a Short-Wright, had devised in conjunction with Booth, though originally intended as a stall-warning indicator. We had a first-class instrument maker and his mate, together with myself and a draughtsman to do the calibration work, but could only cope with a few initial orders for Sheerness Dockyard Stores as we had to undertake other work including servicing two Wright aeroplanes. In all, I had a curious job – servicing works foreman, part secretary and accountant, part experimental flight observer, and part designer. In the spring of 1915, the ASI was handed to a firm for bulk production, and Ogilvie went to the Admiralty as a flying instructor, I went to Harris Booth at the Admiralty, while young Lucking, my draughtsman from Sopwiths who later became an Air-Commodore, went to FTS.*

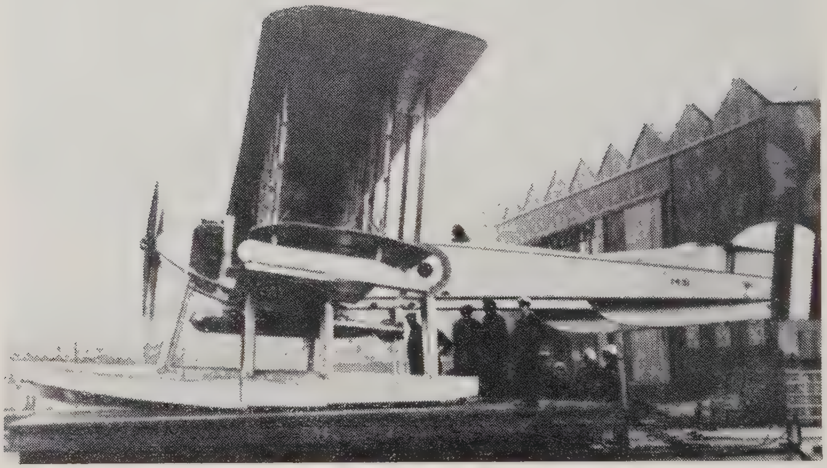
*Fighter Training School.

'The Air Department when I joined was under Commodore Sueter, and was a fairly small organization. I was in D Section which was initially a civilian unit headed by Booth, and there I found Harold Bolas, A. J. Sutton Pippard, H. Watts, and a few draughtsmen. Very soon the section increased substantially, many of the intakes coming as RNVR officers: I recall Steadman, Buchanan, Barlow, Bumpus, Pritchard, Howard, and Wilson. We also had Clifford Tinson, recently of Bristols, who joined in February 1915, and there were three "learned ladies".

'The Admiralty at that time believed (like the Royal Aircraft Factory) in producing its own designs as well as getting firms to design for it. Though I was too late to see it, D Section had done the original design of the "land-ship" from which germ there developed the "Tank". General control of design was by Booth and Bolas; Watts ran the propeller group; Pippard was in charge of stressing; and I ran the drawing office. During this period, Booth launched investigations on which later stress work was based – hypothecating that stressing by bridge-design methods was wrong in assuming fixed supports, whereas an aeroplane's structure distorts elastically. It was this problem which he handed to Pippard and the lady mathematicians – and they solved it brilliantly and rapidly – and which Pippard and Pritchard began to write up in the *Hand-book of Stress Calculations*. The task of the technical staff was to give the mathematicians an aerodynamic basis for the loads falling on the structure as a whole. Ever since, I have had a great respect for "learned ladies".'

In the office above the Admiralty Arch that great and engaging, though perilously outspoken, personality Harris Booth and his handsome assistant Harold Bolas were busy on several major design projects. Already the structure of their giant twin-fuselage seaplane, A.D.1000, with a wing span of 115 ft, was filling the entire width of J. Samuel White's main shed at Cowes, for it was considerably bigger than the great O/100 which Handley Page was building, and with triple 310 hp Sunbeam engines represented a rationalized version of a similar landplane, powered with two Canton-Unné engines of a mere 200 hp each, and designed in 1914 by

The 115 ft span A.D. Type 1000 seen at East Cowes. (*Fleet Air Arm Museum.*)



The third Wight Twin. This had individual structures to the pontoon floats under each fuselage so that bombs or torpedoes were unobstructed. (*Fleet Air Arm Museum.*)

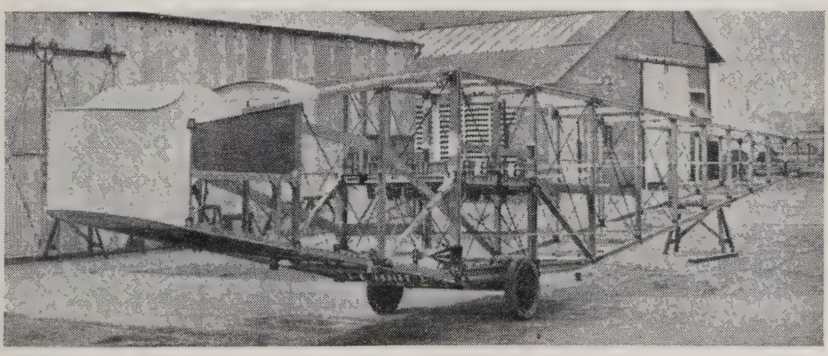
White's doyen aeronautical engineer, Howard Wright. The derived A.D.1000 was intended by Harris Booth as a stand-by in case Handley Page proved too optimistic in formulating his aerodynamically cleaner twin-engined 98 ft span bomber. Indeed, Murray Sueter was very much aware that H.P. so far had achieved only small machines – whereas Howard Wright had produced seaplanes bigger even than those built by Shorts.

For all his urbanity, the massive Mr Handley Page, now 30 years old, had inflexible will, and his engineering and aerodynamic knowledge was perhaps more extensive than any of his pioneer industrial contemporaries. The problems of his ambitious big bomber were tackled with unrelenting energy, and his assistant, quiet George Volkert, proved perfectionist with details. Lightness was everything: H.P. must beat the weight/cube relationship. Although theory indicated that the structural percentage weight achieved by smaller aircraft could not be realized, he nevertheless was aiming at under 40 per cent of the all-up weight. Even if the dual power-plant weight was greater than normal, sheer size should enable the O/100 to carry even greater disposable load than the mandatory six 100 lb bombs, bomb-sight, rifle and ammunition, armour and wireless telegraphy. Re-assessment showed that the empty weight, including dry power units, would be 8,000 lb, but twelve bombs of the new 112 lb standard could be carried if the all-up weight was increased to 12,000 lb. A military load of this order coupled with considerable range afforded by fuel tankage for 290 gallons was regarded as a tremendous step forward – but everything depended on substituting Rolls-Royce engines for Sunbeams, and a gamble as to whether they would develop their envisaged 250 hp.

Cautiously Handley Page adopted relatively low load factors, arguing that the machine would not have to manoeuvre violently – for the extent to which atmospheric disturbances might impose additional large stresses was not within statistical knowledge. In the light of prevailing experience, contemporary design was followed using a two-spar wood wing with wooden struts and wire bracing, carrying a wooden girder fuselage – but it was in conception of detail that Handley Page was determined to score.

He designed hollow spars of the type proposed in 1911 by J. D. Roots for his Patent No. 7965. Despite the wide chord of 10 ft, the contemporary aerofoil-section resulted in a shallow wing, so it is indicative of low load factors that the front spar was only $5\frac{7}{16}$-in deep by 3-in wide, using $\frac{3}{8}$-in spruce flanges and $\frac{5}{16}$-in side walls, with the joins internally stiffened by triangular packing strips. Interplane struts comprised a similar hollow central member massively streamlined with a wide plywood stressed skin.

For easier assembly the fuselage was to be built in four sections, using solid $1\frac{3}{4}$-in square spruce longerons from nose to front spar attachments; the top ones continuing along the 6 ft 10 in high by 4 ft 9 in central section which had deeper I-section beams at the bottom. The next four bays had hollow spruce longerons $2\frac{5}{8}$-in square with walls $\frac{3}{4}$-in thick forward decreasing to $\frac{5}{16}$-in at the rear, and the final section had tapering hollow longerons which were made solid for the bay behind the biplane tailplane. All spacer struts except those in the nose were hollow, and like the compression members in the wings were tapered to save weight, resulting in such narrow end fittings that they might have been designed for a B.E. yet were further lightened by reducing the constituent parts and attaching the cable cross-bracing to outside plates only. To avoid crew fatigue from wind buffeting, a simpler cabin enclosure than the 'greenhouse' of A.D. 1000 was built by sealing the transverse nose bay with a wedge of four panels of Triplex, using Cellon composite sheets for sides and top. Sustaining what everybody considered an enormous weight, was a two-wheeled undercarriage under each wing bay adjacent the fuselage, so



The 63 ft fuselage of a production Handley Page O/100 is moved to the covering shop after the woodwork has been Copal varnished and metal fittings japanned. Bombs were carried internally in the lower bays adjacent to the trolley wheels.

devised that if the spring units failed in a heavy landing, a stumpy central skid at the apex of the V primary structure took the load.

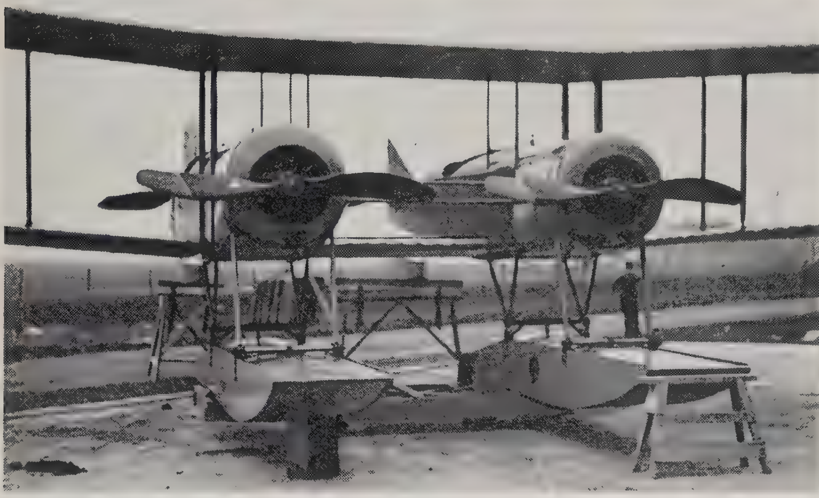
Every feature of the hush-hush 'Giant' seemed to add to its impressiveness. Even the necessity of shortening the lower wing so that its tip would clear the ground when folded added distinction because of the dominant top wing overhang and the protruding horn balance of the ailerons, and so did the device of using a 20 ft biplane tail to save weight and reduce the blind spot compared with a monoplane surface. The elevators were horn balanced, and a central fin was mounted between the tailplanes, with finless balanced rudders outboard.

With his unique drive and enthusiasm, H.P. was directing every department of this project. One moment he would be driving his technicians at top pressure, or arguing with Admiralty representatives – and the next he was forcefully dealing with purchase of materials or in the shops slating slow progress of construction in the hands of his long-suffering works manager, C. W. Meredith, a pre-war pilot.

Herbert Smith of Handley Page, and unrelated to the Sopwith designer, recollected: 'I joined the company in February 1915 as one of about twelve employees. The work was just beginning on small details for the O/100 which, after the first 25 machines, became the O/400. Modifications were as prevalent as now. Blueprints were issued to the shops, mostly in detail form; but for a considerable period, paper sketches – often of undeveloped fittings – became very prevalent, and marking out the templates for these was done by those more adept, more accurate and quicker than the others. During this time there was no one producing jigs and tools as such; consequently fitters made between them a goodly number of bending blocks. Even the largest fittings were bent and formed with these simple tools.'

Perhaps Harris Booth also seemed sceptical of H.P.'s promises and as further insurance against failure of the O/100 recommended the Admiralty to order from Hewlett and Blondeau a smaller capacity 70 ft biplane, powered by twin 120 hp Beardmores – based on a machine designed by an enterprising pre-war airman, George Dyott, for a South African exploration in 1914.

Robert Blackburn was similarly favoured. Inadequate finance and his modesty had hitherto held him back compared with other pioneers, nor did he receive a production order for his rather unexciting Type L seaplane, though the prototype had been purchased by the Admiralty early in the war. Possibly it was no great loss that on the delivery flight by Blackburn test pilot, Rowland Ding, erstwhile owner of the Handley Page Type G biplane, it was wrecked after drifting into a cliff when forced to alight from engine failure. However, the War Office had established production facilities with reasonable contracts for B.E.2cs, and this led Robert Blackburn to suggest building a machine for the Admiralty, utilizing twin B.E. fuselages to comply with Harris Booth's favourite formula – a system patented in 1914 by S. W. Hiscocks and S. J. Waters of the Royal Aircraft



The prototype Blackburn T.B., and the first eight production aircraft, had semi-enclosed 100 hp Gnome engines, but the last (below) had 110 hp Clergets in Sopwith-type cowls. For folding, the thick inboard struts divided vertically.

Factory. Acceptance of the proposal resulted in a seaplane reminiscent of a half-scale twin-White, but all that was finally incorporated of B.E. design were modified tail components and numerous fittings, for the fuselages became deeper than the B.E., and each nose had an overhung 100 hp Gnome Monosoupape with annular cowl. The vital feature was an unobstructed torpedo-carrying space between the independent float structures. Early in 1915 two prototypes were being constructed.

6

March saw increasing air activity at the Front. Several Renault-powered B.E.2cs had been fitted with a newly devised vertical conical box-camera mounted to starboard outside the pilot's cockpit, which that pioneer pilot Lieut Moore-Brabazon, RFC, assisted by Lieut Campbell, had built in co-operation with the Thornton-Pickard Company. By employing this last

word in photographic machines, augmented by others having only a hand-held camera for oblique shots, the RFC conducted their first comprehensive recording of the German trench system – bringing back valuable information to the Army commanders planning to attack Neuve Chapelle. Even the obsolete wing-warping unstaggered B.E.2 was modified to single-seat bomber rôle, and when the battle opened on 10 March, attacked hostile trains and railways to delay reinforcements. Next day came the town's capture, and with it the Government cashed in by inducing newspapers to print in heaviest type an announcement from Kitchener that victories like this could only be ensured by adequate munitions and tools of war. Every non-combatant worker must throw the utmost effort into such production: every available man must enter the Army by summer.

Typical flying kit for the open cockpit of an early B.E.2c which has a starboard outboard camera mounting so that the pilot can use his right hand to change plates. (*D. F. Woodford.*)

A few days later the daily Press revealed column after column of shattering casualties. For a small advance the cost had been terrible. Despite photographic record of enemy dispositions there had been no effective battle co-ordination between Army Command and air reconnaissance squadrons. As a result the whole operation fell into confusion. Many sections of infantry became isolated, unable to discover what to do; artillery fired blindly, the accuracy of their shooting unknown because reliance had been placed on ineffective methods based on peace-time manoeuvres. Pilots had been instructed to imagine arbitrary target circles of varying radii denoted by alphabetic letter and from the draughty cockpits of the handful of Maurice Farmans and B.E.2cs must spell out in amateur Morse the hour angle and radial reference, using primitive Sterling one-way radios weighing a colossal 220 lb yet incapable of trans-

mitting more than eight miles. In the stress of battle – where flashes of gunfire seemed unrelated to explosions and bursts of smoke – it was impossible to be accurate, or understand whether the artillery, signalling back with scarcely distinguishable Popham panels of white strips on prearranged panels, had read the message accurately. All too late the Army Command realized their early distrust of aircraft and neglect in developing communication methods had led to incredible waste and near disaster. With urgency the War Office instructed the Royal Aircraft Factory and wireless set manufacturers to co-operate in producing lighter apparatus with longer range, capable of two-way transmission.

The Maurice Farman Longhorn was used for preliminary training, but the Shorthorn version, which had a longer nacelle and the forward elevator structure removed, had brief operational use for artillery spotting. (*R. E. Nicoll.*)

Colonel Sykes's contention that reconnaissance machines on both sides would be harried and destroyed to prevent transmission of vital information was being proved correct. At the end of March a particularly perceptive war-reporter defied the mild censorship at the Front by writing of a startling innovation: 'Firing with a machine-gun between the blades of a propeller revolving at something like 1,200 rpm strikes one as very tricky, not to say a risky pastime, but I have it on good authority that it is the latest exploit of Roland Garros, the famous French pilot, and resulted in bringing down two Taubes. According to a patent specification in a German paper, an inventive genius over there has a device enabling a machine-gun to be fired through the disc area of the propeller by gearing the trigger of the quick-firer to the engine so that when a propeller blade is in line with the gun a lock prevents the shot being fired until the blade has passed out of the line of fire.'

This interrupter gear was undoubtedly the Schneider, patented in 1913 by the Swiss-born designer of the German L.V.G. Werke, and although developed in England by the Edwards brothers, it had been turned down before the war by the War Office as an unnecessary complication. In June 1914, Raymond Saulnier, who had designed the wings of Blériot's famous cross-Channel machine, produced for Morane-Saulnier a synchronizing gear, but due to back-lash it proved too erratic with the particular gun

used. As a simpler solution Saulnier had therefore fitted the roots of the propeller blades of the Gnome Morane used by Garros with armour steel wedges to deflect bullets striking them from the fixed gun on top of the fuselage – though most shots happened to go safely between the blades at each revolution.

On 19 April Garros had engine trouble and was forced to land near Ingelmunster, the Germans capturing his machine intact thus discovering exactly how he had been able to 'fire through the propeller'. Realizing it

Fitted to the propeller of this Morane Bullet is a development of the deflector used by Garros which impelled development of Fokker's gun synchronizing gear. (*Imperial War Museum.*)

could be done by less dangerous but more effective means they instructed Fokker – who had produced a machine almost identical in appearance to the Morane but with a welded-tube fuselage – to fit a Parabellum gun in similar manner and design an automatic safety firing device.

In England a Vickers-Challenger mechanical gear was already available, but had not yet proved sufficiently reliable. Patent 17,385, of 11 December, 1914, stated that it provided 'a rotary member between the gun and the propeller which rotates in synchronism with the propeller and serves to deflect bullets when the propeller blades are in the line of fire'. This patent was preceded by two days with one numbered 23,790, granted to A. H. Edwards, applicable both to a fixed gun or one capable of deflection, using the mechanical interrupter covered by the Anglo-German Patent 16,726 of 1913 describing Schneider's invention.

Harry Kauper, foreman of the Sopwith fitters and deputy to Sigrist, was working on his own form of mechanism. Big, slow of speech and movement, he was one of several Australians who emigrated to England before the war, inspired to take up aviation largely through seeing a Bristol Boxkite demonstrated in their country. Working independently, but known to the Vickers and Sopwith groups, was Warrant Officer F. W. Scarff, employed as a draughtsman at the Admiralty, who was developing a somewhat similar synchronizing gear to Kauper's based on the ideas of an immigrant Pole, Lieut-Cdr V. V. Dibovski, late of the Imperial Russian Navy. Another experimenter was Major Bettington of the Aeroplane Repair Section of No. 1 Aircraft Depot at Farnborough who had a gear made to his design by Ross and Arsiad.

Meanwhile a Roumanian rock drill expert in England, Gogu Constantinesco, of the Haddon Engineering Works, Honeypot Lane, Alperton, in Middlesex, had been investigating transmission of impulsive forces through liquids. His Patent 9029 of 1913, dealt with 'a method of transmitting power by a wave motion in liquids by means of a series of periodic changes of volume and pressure travelling along a liquid column, the changes of volume and pressure being of harmonic form'. His managing director, Walter Haddon, was convinced that this opened a new field of hydraulic transmission which could replace mechanical linkages and avoid lost efficiency, but as yet there was no inkling that it might be particularly valuable for gun interrupter mechanisms.

7

Despite Press censorship there was increasing talk of industrial trouble. Engineering workers and shipwrights were proving more suspicious of exploitation than food processers or country labourers, and it led to constant difficulty. Particularly in shipyards and munition factories, hearsay and exaggeration were inducing belief that management and shareholders were making huge profits. Increasingly this led to underground agitation among workmen for a share of the swag. Sense of patriotism had long evaporated in the scramble for money.

Feeling swiftly mounted against the dissatisfied ranks, whose feckless ways, pub crawling, and bad timekeeping seemed a scandal. Antagonism between middle-class population and the great concourse of factory hands rose to feverish pitch when Lloyd George, as Chancellor, declaimed: 'We are fighting Germany, Austria, and Drink', on introducing his April Budget proposals for drastic increase in Duty on intoxicants in hope of checking consumption; but so great was the outcry among the 'workers' that the Government dared not proceed, and instead imposed limited control in scheduled areas. Smoothly, the plausible Lloyd George sidestepped his imputation of drunken workers, and turned to what he called 'a remarkable development in munition production' – for the index figure of 20 in September 1914 had become 388, and was showing steady growth. On 16 April he was appointed chairman of the new Committee of

Munitions, composed of representatives from major engineering firms who would control this vital war-time production.

Barely had the idea been assimilated than startling news came of British troops under the command of General Ian Hamilton forcing a landing in the Dardanelles and the Gallipoli beaches. Pictures showed a narrow beach crowded with topee-helmeted men, their khaki jackets opened or flung aside in the heat. Guarded by spasmodically ranging shells from British warships to keep the Turks at bay, they awaited orders a long day and night, only to receive from every rocky height a withering gunfire attack. Advance was impossible. A week later the terrible cost in lives of the Gallipoli landings was revealed. A scapegoat was needed, and it had to be Churchill who had long advocated this second Front, assuring Kitchener that the Navy alone could force the Dardanelles. Critics could now say that the bombardment of the entrance forts by HMS *Elizabeth* in February had given fatal warning of intent to invade, giving time for the Turks to prepare strong defences.

Rumour had it that Churchill would be leaving the Admiralty for the Colonial Office, where as C. G. Grey said: 'he would have greater prospects of success, for his hustling methods, derived doubtless from his American ancestry, would probably agree with those of other young men on the outposts of the Empire. Mr Churchill has always been a young man in a hurry. Young men in hurries have made most of the mistakes in history, but they also made most of the progress. Not only the RNAS but the RFC owe their present supply of aeroplanes to Mr Churchill, for without his backing the Air Department of the Admiralty could not have ordered aeroplanes as it did, and several firms would have been "broke" which have since supplied most efficient and effective aeroplanes. In any case the whole country owes Mr Churchill a debt of gratitude not only for encouraging the supply of aeroplanes but for his mobilization of the Fleet at Spithead in July 1914. That "monkey-jacket Review", at which the RNAS made its first official appearance, bottled the German Fleet and ensured our food supplies.'

Quickly following the Dardanelles disaster came headline news read with even deeper shock: 'The Germans have sunk to the depths of bestiality by using poison gas on the salient in front of Ypres.' With amazement the British troops saw a mist drift forward from the entire line of German trenches, growing denser as it slowly moved over the shell-pitted area of No-man's land into the Allied lines. Suddenly they realized it was yellow chlorine. A few managed to tie handkerchiefs across their mouths – but man after man was wiped out, choking away his life. It was the most terrible form of carnage yet sprung upon the world. Clearly the Germans were prepared to go to any lengths.

On 7 May newspaper boys startled London streets and principal towns with special editions, shouting: 'Disaster to the *Lusitania*.' The news was as devastating as the loss of the 'unsinkable' *Titanic* in pre-war days. Crowded with troops, the *Lusitania* had been torpedoed by a U-boat off

the Southern Irish coast and sank at once, only a few boats getting away. Some 1,200, including 124 Americans were drowned or killed – and a few days later the horror was forced home with shattering pictures of lines of drowned little children lying on the floor of a mortuary. The great liner had been carrying no war materials. Unbridled rage was everywhere expressed against the enemy, for the torpedoing seemed even more inexcusable to British minds than gas attacks. Yet only a fortnight earlier the German Embassy in the USA had issued a trenchant warning in major American newspapers:

NOTICE!

> TRAVELLERS intending to embark on the Atlantic voyage are reminded that a state of war exists between Germany and her allies and Great Britain and her allies; that the zone of war includes the waters adjacent to the British Isles; that, in accordance with formal notice given by the Imperial German Government, vessels flying the flag of Great Britain, or of any of her allies, are liable to destruction in those waters and that travellers sailing in the war zone on ships of Great Britain or her allies do so at their own risk.

IMPERIAL GERMAN EMBASSY
WASHINGTON, D.C., APRIL 22, 1915

Rumour spread like wildfire that spies revealed the sailing date to the Germans. Fanatical hatred again blazed against anyone with a German name, and crowds everywhere raided shops and restaurants owned by aliens. Even the Royal Exchange requested members with such names to absent themselves. Questions in Parliament revealed 40,000 people of enemy origin at large in Great Britain. Spy hunting reached fever heat, and many innocents suffered denunciation to police and military. Matters were rendered worse on 31 May with the first big Zeppelin attack on London, when nine bombs were dropped, and four people killed.

In France, fighting was becoming more acute at Joffre's behest. At Arras and Festubert the British were gaining ground; in the Dardanelles the Australians at Anzac Bay, despite initial set-back, had made good their foothold; but on the Eastern Front the Germans were breaking the Russian line in Galiceia. It was significant that on 23 May, Italy decided to support the Allies, declaring war on Austria – though not on Germany – but there was increasing astonishment following the *Lusitania* outcry, that the USA, with their commonalty of language, had not allied with Great Britain in what Americans called 'The War for Freedom' and which every British fighting-man believed was the war to end all wars.

But the USA seemed to be dragging its feet. America's population of 95 million was by now more than twice that of the United Kingdom. Between the two countries flowed the greatest exchange of imports and exports in the world. Because war was utterly contrary to American policy, except under the Monroe doctrine, it was not understood in England that Congress must play cards with caution, for involvement in European war could disastrously affect the reaction of their voters, as people in many parts of the country hardly realized there was such a place as Europe, and

in any case did not care. Yet a hard core of businessmen in New York and industrial northern cities was anxious to aid Britain and her Allies with war materials for obvious reasons.

Though in England the Members of Parliament were elected 'by the people for the people' in the same way as the American Congress there was growing feeling that Cabinet activities were kept so secret that MPs could not exert lawful control. Increasingly it became evident there was open disagreement within the Government. Even Kitchener was being openly attacked by Northcliffe in the *Daily Mail*. When the Press announced that Admiral 'Jackie' Fisher had not been at his post at the Admiralty for the last few days, it was obvious things were very wrong. In club and office, criticisms and apprehension grew – for a party divided within would be fatal when unity of thought and action was essential between the fighting and civilian groups. Before the end of May the feared collapse had come. Asquith, as Prime Minister, made urgent efforts to form a representative Government by coalition of all parties. Most of the Cabinet had no hesitation in placing their Office at his disposal; but Haldane and Churchill resigned. Arthur J. Balfour was appointed to the Admiralty; Bonar Law went to the Colonial Office; Lord Curzon was made Lord Privy Seal; the brilliant but caustic Sir Edward Carson became Attorney-General; the energy and drive of Lloyd George established him as Minister of Munitions; and the Labour man, Arthur Henderson, went to the Board of Education. *The Times* described the coalition as 'the last effort we can make under our accustomed conditions of public life'.

With his usual pertinacity for matters political, C. G. Grey commented: 'The resignation of Mr Churchill from the Cabinet is a matter on which he is to be congratulated. Readers of *The Aeroplane* well know how much Mr Churchill has done for aviation. He lacks balance it is true, but he possesses strategic talent, and if his activities were toned down by counsel of older men he would be of very high value. His exclusion from the War Cabinet in favour of three lawyers, a merchant, and a philosopher is to be regretted, but he could not remain in the Cabinet and retain his own self respect. It is to be hoped that in due time his tireless energy and great ability be turned to good account.'

8

In the preceding months there had been every sign that the British commonalty would pursue its week-end distractions whatever the pressures of war. Under the heading HENDON - THE 1915 SEASON OPENS, *Flight* reported: ' "Flying as usual" is apparently once more to be the motto at Hendon, judging by the first weekly meeting for 1915 held during the Easter holidays. Unfortunately conditions were hardly as pleasant as desired, especially Saturday, when flying was cancelled owing to wind and rain. Sunday and Monday made up for this disappointment in every way – Hendon looking its old self. The band played, the megaphone man announced events, and the huge crowd in the popular enclosures took "tea as usual", so there is

every prospect of these meetings achieving their customary success. That there was no lack of petrol was confirmed by ranks of vehicles in the "motor-car paddock". Sadly enough, Victor Mahl, the Sopwith assistant pilot to Harry Hawker, died after an operation for appendicitis the evening before the Hendon opening. A 25-year-old of unflagging cheerfulness and ready wit, he had quickly proved a first-class pilot, taking up several passengers the very day he gained his Certificate. Thereafter he became the regular test pilot of the firm, and for months has been busily passing Sopwith machines through their tests for the Government, frequently flying several a day.'

Though Hendon displayed a carnival air at week-ends, all major companies were expanding their factories swiftly for the serious purpose of war. Typical were Martin and Handasyde, who in April converted their business into a limited company under the name of Martinsyde Ltd, acquiring larger premises at Woking to augment the output of their small Brooklands works. A contributor to one of the aeronautical weeklies reported that he 'had opportunity of seeing a new Martinsyde two-seater the other day, and was particularly struck by its obvious strength. Pilots who have flown it say this machine is to all intents inherently stable. Mr Raynham has made a descent of several thousand feet with engine stopped without touching the controls – which seems fairly good proof of stability. The makers state that the machine is not yet perfected, but it certainly strikes one as able to hold its own with anything of the kind in the possession of the RFC.'

The Martinsyde Trainer eliminated centre-section side bracing by the use of inverted V-struts. The machine was used to the end of the war by Herbert Sykes when commuting to and from testing engagements. (*Courtesy J. M. Bruce.*)

The new aeroplane was a two-bay biplane, largely designed by Handasyde's chief assistant, A. A. 'Tony' Fletcher, and had all the hallmarks of construction and form displayed by the earlier S.1 single-seater, such as big aluminium flitch plates on the fuselage and a characteristic skid undercarriage with two small forward wheels in addition to the main ones. Powered by an uncowled 80 hp Anzani radial bolted to the square-cut nose it was far from possessing the attraction of the rakish Avro 504 or the B.E.2c, though a slight technical advance might be conceded as it was designed with stronger load factors. There seemed little likelihood of

adoption by the RFC, but it was paving the way to design of a big single-seat reconnaissance bomber of similar two-bay arrangement – the G.100.

In his new post as Minister of Munitions, Mr Lloyd George visited the expanded works of the British and Colonial Aeroplane Company to give his first 'pep' talk, and was ceremoniously received by the chairman, Sir George White; Stanley White, the managing director; and H. White-Smith, the secretary. Conducted through the extensive shops by the works manager, Herbert Thomas – nephew of the chairman and an active Bristol pilot until injured by a propeller striking his head – the Minister watched with fascination the aeroplanes being erected. Addressing the men afterwards he said: 'There is no more important work than you are

Scene at Filton – erecting a Bristol Scout and Bristol-built B.E.2ds which had dual controls and external gravity tanks. These hangars still existed a quarter century later. (*Bristol Aeroplane Co.*)

doing. As I was telling the Munitions Committee in Bristol, you will find no finer airmen than British aviators – but we must have more aeroplanes. I am glad to see you performing so skilfully at this exquisite work. This is the first time I have visited a factory of this kind and I have been extraordinarily interested in seeing the work you are doing. The more machines you can turn out the better can our splendid aviators and observers find out exactly where the trenches and guns are, and then our artillery will get to work, and when they have smashed away defences, our infantry will turn the Germans out of the trenches – but your job is a first great step.'

A week later, Lloyd George visited the Aircraft Manufacturing Company at Hendon, whose headquarters were now The Hyde in Edgware Road, though the head offices remained at Westminister where Holt Thomas presided. Orders had duly been received for the modified 1A version of the D.H. pusher. The somewhat complex oleo originally concealed in each apex of the V-undercarriage had been changed to simple direct springing using a skein of bungee, and wire bracing cables were replaced with the duplicated streamlined Rafwires introduced on the B.E.2c. Except for an initial batch with Renaults going through the shops,

The D.H.1A, built by Savage Ltd, had a sturdier undercarriage, stiffened wing structure with Rafwires, and 120 hp Beardmore with radiator behind and above the rear cockpit. A few were used for Home Defence and the majority as advanced trainers.

construction of the Beardmore-powered D.H.1A would be sub-contracted to the King's Lynn woodworking firm of Savage Ltd to make room for D.H.2 production at The Hyde factory.

The little prototype fighter had recently been completed. Consultation with Colonel Lewis, an American inventor, had resulted in duplicate mountings for his quick-firing air-cooled gun either side of the D.H.2 nacelle, giving variable deflection but only limited freedom to swivel. On the great day of the initial flight the pretty little pusher waited on Hendon aerodrome with the sun shining through its clear-doped translucent wings to reveal the blue, white, and red wing-tip roundels which had just been approved as British identification symbols. Trailing a cloud of blue

The neat little production D.H.2 which General Rawlinson, G.O.C. Fourth Army, reported in May 1916 '. . . has unquestionably proved itself superior to the Fokker in speed, manoeuvre, climbing, and general fighting efficiency.'

smoke from the purring Monosoupape, de H. got it airborne with a very short run, and presently returning seemed delighted with the handling.

In April the Aircraft Manufacturing Company had gained a new recruit in Charles C. Walker, AMICE, a mature 38-year-old well versed in civil and mechanical engineering. Prevented by a defective leg from joining up, he had written to de Havilland asking if he could be of use in this new and interesting subject of aircraft design. When they met, each was impressed with the other's personality, knowledge, and sincerity. Of medium height and rugged appearance, Walker had no airs, no exaggerations, and conveyed his thoughts with Spartan factuality. In *Sky Fever* de Havilland wrote: 'When we began discussing salary Walker said, "Wouldn't it be better if I came for no salary for a time, and you could then decide whether to take me on for a further period on normal terms?" Charles Walker proved to be not only exceptionally able in his work, but one of the most lovable personalties I have ever known, and became one of my oldest and best friends. One of his endearing habits was always to see and accentuate what is good in a person and to belittle their faults, and without being in any way extreme he could always point to some good in a situation that seemed at first sight to be nothing but troublesome and difficult. His technical work, largely connected with stressing and aerodynamics, was always an asset of great value – but he has also contributed an indefinable something towards the high standing of our company.'

De Havilland himself was now directly answerable to Hugh Burroughes, who, at the time of leaving his administrative post at Farnborough to become general manager of the Aircraft Manufacturing Company, had with considerable skill and subtlety induced an unsettled de Havilland, as AID Inspector of Aircraft, to offer his design services to Holt Thomas, and had simultaneously persuaded Holt Thomas of de Havilland's great honesty of purpose and undoubted potential value.

This single-seat Trainer was devised by C. M. Poulsen of *Flight* and built by Ruffy, Arnell and Baumann Co to obtain official recognition.

CHAPTER II

MUCH TO DO

1915 (*cont.*)

'Sirs, you se how long we have bene here, and wages we have none, our living riseth on the gaine of our enemies, and synth our beginnynge we have had good chaunce in all our enterprise, God be thanked: nowe the winter draweth nere, let us now aventure to get som good bootie, to make us merry in the cold weather, and yf you wyl we shall enterprise a thing that I truste to us shall bee profitable.'

Edward Hall (1530)

1

OF THE many extraneous companies turning to aircraft production, Petters Ltd of Yeovil was typical. Operated by twin brothers, Percy and Ernest Petter, a sound business in manufacturing small industrial engines had been established. At the turn of the century Percy had been introduced by his chief designer, W. Jacobs, an engineer of long experience in Somerset, to the son of that great model aeroplane experimenter of the mid 1800s, John Stringfellow. By profession a dentist, Frederick John Stringfellow had inherited his father's house at Chard and still possessed many of the models, as well as several versions of his own. Prompted by conversations with Stringfellow, Percy Petter discussed with Jacobs the possibility of designing an aeroplane powered by a light internal combustion engine, but, although he made a few experiments 'with helicopter lift', the oil engine business necessitated his full time and attention, so flying machines were regretfully abandoned.

But in 1915 it was very different. Percy as a member of the West of England Auxiliary Services was investigating the possibility of manufacturing 18 lb shell cases locally. Not long before the war Petters Ltd had decided their premises in the middle of Yeovil were too small, and bought a fine piece of meadowland alongside the Western, Yeovil, and Taunton Branch Railway, where sidings were made and a splendid new foundry built which employed a score of woodworkers as pattern makers. To the north, spreading westward from Yeovil, were fields hedged with blackthorn and elm, and it seemed a wise financial safeguard to purchase this

area for a possible garden village on the lines of the Cadbury brothers' Bournville. As a start a road was made through the proposed site to the foundry, and Mrs Percy Petter named the new estate *Westland*.

Two years later, in this April of 1915, Ernest Petter proposed to his co-directors 'that the resources of the company be placed at the disposal of the Government for the manufacture of any type of war materials which it considered we could undertake'. But their chairman and friend, William R. Moore – a man of great charity – was so opposed to the idea of war that he could not agree to manufacture munitions, and as minority voter resigned his seat and chairmanship. In his place Ernest was elected, and the Petter brothers then offered their company's services to the Board of Admiralty and War Office. There was no reply from the latter, but their Lordships of the Admiralty agreed the company might undertake construction of naval aircraft, and requested them to send a representative to the works of Short Bros at Rochester to learn at first hand what was required.

'I must confess that my heart nearly failed me when I saw the nature of the work involved,' recorded Percy Petter, 'but Mr Warren, the partner of my architect brother John, was very sure of his ability to supervise the construction of such machines, so we agreed to go ahead and were given fifteen Type 184 seaplanes to construct.

'We put Mr Warren and John in charge of the Works, but I was not satisfied that their experience was adequate for this difficult undertaking, but recollected that a year or so earlier, when we had a vacancy for works manager of the engine business, I interviewed a Mr Robert Arthur Bruce who was then with the British and Colonial Aeroplane Company but I had thought his talents would be wasted on the construction of engines. I now kept saying to myself "If we could only get hold of that Mr Bruce, he is the very man we want for the aircraft business," and I eventually managed to contact him through the Institution of Mechanical Engineers.

'Mr Bruce duly replied that he had lately been commissioned Lieutenant RN and appointed Admiralty Inspector at Sopwiths. We then met at the Constitutional Club, London, and he agreed that, provided the Admiralty would release him, he would join us as manager of our aircraft works. In due time this was accomplished, and under Mr Bruce's painstaking care we were safely guided through all the difficulties of aircraft construction.'

Soon after joining the Westland Works of Petters Ltd, Robert Bruce, MSc, engaged as clerical assistant Robert J. Norton with whom he had previously been associated when working with that great but erratic Australian inventive genius Louis Brennan on gyroscopic applications to monorail systems. From the Petter engine design staff the chief draughtsman, Arthur Davenport – a stocky young man who had been trained at the engineering firm of Ruston, Proctor Ltd – was placed in charge of scheduling and progressing the sequence of drawings issued to Westland by Shorts, and one of his early tasks was to make drawings of the still incompletely designed bomber version of the Short 166 twin-float seaplane for the next constructional contract. Always fascinated with the idea of flying,

Originally designed as a torpedo carrier with arched braced axles between the floats, the 200 hp Canton-Unné Short 166 was later built with straight axles by Westland as a bomber carrying three 112 lb bombs. Note centre-section sling bridle and detachable jury strut.

he had at the beginning of the war unavailingly tried to exchange his job at Petters for one at the Royal Aircraft Factory, but now found his real *métier*.

Contracts for Short seaplanes introduced a diversity of companies to aircraft construction, for the carpenters of famous shop-fitting businesses and car-body builders proved ideal for wooden aeroplanes, and even packing case builders were adaptable. Thus at the Phoenix Dynamo Co Ltd of Lytham St Annes, Lieut W. O. Manning, RNVR, the ginger-haired aircraft pioneer of Brooklands days, had just been appointed technical manager of their newly formed aircraft department. Victor Gaunt, one of his early assistants, describing his own introduction to aircraft, said: 'At the beginning of 1915 I tried to join the RNAS, but my firm the Phoenix Dynamo Co (now part of the English Electric Group) refused permission because I was working in the drawing office on generators for HMS *King George V* and HMS *Centurion* – so when we were asked to make aircraft I was enormously pleased, and because I had some little knowledge of aeroplanes and had been to all the early flying meetings in this country, I was selected, with two other draughtsmen, to go to Shorts' Rochester Works, to help with drawings. There I met Arthur Davenport who had been delegated from Petters. At that time Dick Fairey was Shorts' works manager, but almost immediately left to commence on his own as a constructor. My job was to measure the prototype and produce drawings for the tail unit and engine cowl, while my colleagues made material schedules. Three weeks later, Lieut Stronach, RNVR, who was the Brush Electrical Engineering manager, and W. O. Manning as our designer and technical head, started up their individual aircraft departments at their firms. Lieut "Freddie" Rowarth, RNVR, was appointed Admiralty Technical Officer, and helped enormously as liaison in getting the right materials, technical data sheets, and so on. Indeed all we sub-contractors were very ignorant of aircraft manufacture, depending on interchange of information between

each other and on the Air Board and Admiralty for essential guidance, with the invaluable help of Bibby and Lipscomb of Shorts.'

C. P. T. Lipscomb, as a trained engineer aged 27, had quickly gained Horace Short's confidence. Apprenticed at the Royal Arsenal at Woolwich, he became friendly there with Harris Booth, and at Woolwich Polytechnic obtained a Whitworth Exhibition in 1908, afterwards joining the Coventry Ordnance Works as a draughtsman on the design of gun-houses for the battleships *Conqueror*, *Ajax*, and *Benbow*.

'In July 1914,' he recalled, 'I received a letter from Harris Booth strongly advising me to take up aviation, and he said a vacancy was available at Shorts as a stressman to Fairey. I applied and was accepted, though my

The Short 827 was the ultimate revision of Type 166, and became standard equipment at many RNAS coastal stations both for patrol and training. A number served in the Mediterranean and Africa. Thirty were built by Shorts and 72 were sub-contracted. (*Courtesy G. S. Leslie*.)

colleagues at Coventry thought I was very ill advised to give up a highly specialized engineering job to work with bits of wood and piano wire. Nevertheless, such was my faith in Harris Booth that I had no qualms at all, and celebrated the occasion by getting married one week before joining Shorts.

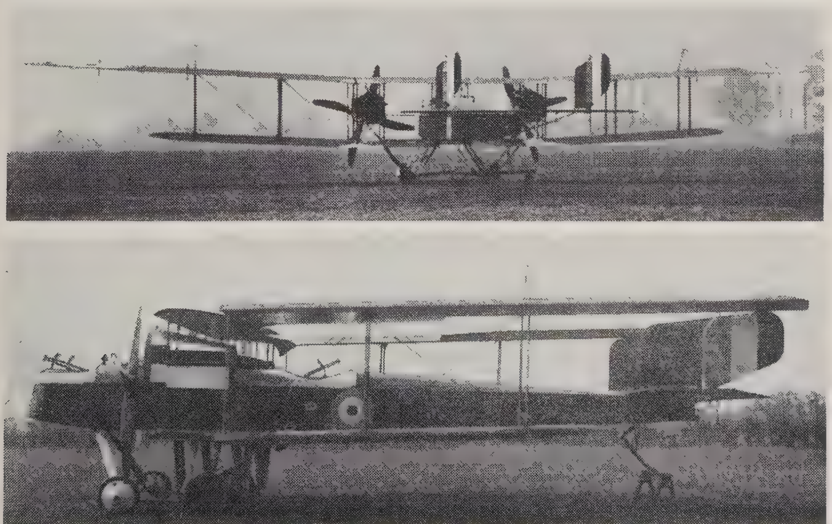
'I found they had a staff of about a dozen. The chief draughtsman was P. M. Jones – a very good man, and another excellent designer was Francis Webber who was largely responsible for detail design. As far as stressing went, all we could do was apply ordinary engineering principles, supplemented by rather primitive structural testing under the guidance of that outstanding and remarkable character, Horace Short. Our mainstay on wings was that old friend, the Theorem of Three Moments. Most of the load assumptions must have been somewhat dubious, but I do not remember any serious structural failures – probably because top speeds were so low that rapid change of stress did not occur. Nevertheless I think we were lucky at times.'

The advent of war made Horace Short's general factotum restless – that same tall and commanding Dick Fairey who had assisted Dunne with his tailless machines before the war. After attempting to join first the Royal Naval Air Service and then the Royal Flying Corps, he had been firmly

told by Commodore Murray Sueter that his job was to design and build aircraft. Through mutual contact at Shorts they knew each other well. Each had inflexible determination to overcome obstacles, and appreciated the measure of the other – so it is not surprising that Sueter applauded Fairey's ambition to start his own aviation company. Vincent Nicholl, 'Wuffy' Dawson, and Maurice Wright – those erstwhile wealthy Cambridge undergraduates whom Fairey had met in the first flush of earlier exciting days at Eastchurch – though now in the Navy, were prepared to back him. Indeed Dawson came from a rich family whose wealth derived from participation in the Hudson's Bay Trading Company, so sufficient capital was forthcoming. With support assured, Fairey took a small office in Piccadilly, and with the blessing of Horace and Oswald Short, registered the Fairey Aviation Company in the early summer of 1915.

As a friendly gesture, Horace promised a sub-contract for twelve Type 827 seaplanes fitted with the 150 hp Sunbeam – a machine practically identical in structure and appearance with the Type 166 sub-contracted to Westland, but smaller and lighter, and featuring steel-tube interplane struts. What Shorts did not realize was that Dick Fairey took with him not only drawings of the 827, then being test flown by Ronald Kemp, but also a folio of others such as a projected large single-engined bomber which Harris Booth had been discussing.

To build a war-time factory would take more time and money than Fairey thought expedient, but he discovered that on the north side of the Great Western Railway, in Clayton Road not far from Hayes station,



The first Fairey to be built was F.2 – a landplane equivalent of the twin-engined Blackburn G.P. development of the T.B. Folding wings were mandatory even for large naval aircraft otherwise existing hangars could not be used, and were also a facility when picketing out.

there was an army motor-lorry company with whom he arranged to co-operate, using half the premises for the manufacture of aeroplane parts, leaving the other half for vehicles. On the opposite side of the railway he bought a field bounded by North Hyde Road, and built a wooden shed, barely large enough to take more than one completed aircraft, where the factory components could be erected and the finished aeroplane flown away. In a corner of the field was a cottage occupied by a character called Nobby Hearn who owned rights of way which affected the site. Failing to buy him out, Fairey let him stay in an undefined capacity as a watchman in return for free use of the area.

Soon there was difficulty with the owners of the Clayton Road factory, who finding that the aircraft business was prospering tried to encroach and run it. Precisely what transpired remains a mystery, but it seems that Fairey thought his equipment and constructional work might be seized, so gathering his henchmen around him, that very night everything was taken across the railway line and dumped in the wooden shed – yet only a few days later he was back at the Clayton Road factory, in full possession and control not only of his half, but of the entire building.

He never forgot the men who helped him in that crisis. Two in particular took charge: one was Nobby Hearn, and the other was Charlie Hibbert at that time works foreman, known as 'Ibbert of Ayes', who was steadily advanced until he became the managing director of the Fairey Aviation Co of Canada Ltd. But Nobby never became more than foreman of the yard gang in perpetuity, and was the only man in the place who dared call Sir Richard Fairey, Dick.

When contracts poured in it became essential to build more factory area, for which Fairey proposed to use his North Hyde Road field where an existing small factory could be incorporated. But that was impossible without Nobby Hearn's consent. Fairey tried to buy him out, smoke him out, and cajole him out – but he remained fast. 'I know you, Dick Fairey,' he used to say when relating this story. 'So long as I remain 'ere I gotta job for life. You don't trust me, and I don't trust you, so 'ere I stay until I die.' And so he did, abusing all and sundry.

Because initial Fairey production was for Short seaplanes it was necessary to find further facilities adjacent to water, eventuating in the acquisition of Admiralty sheds and a slipway together with a cheap but useful stretch of marshy field at Hamble Point on Southampton Water. There the sheds were converted into erection shops in readiness for the first Type 827 to emerge from Hayes.

Seaplanes were too dependent on smooth water to be the full answer for naval use, so the Admiralty was pursuing construction of flying-boats. As Clifford Tinson relates of his experience with the Air Board: 'I was not at the Admiralty very long. They sent Harold Bolas, Harold Yendall and myself down to Pemberton Billing's (soon known as Supermarine) to build the airframe of the Admiralty designed *Sumbote*, the hull of which was designed by Linton Hope and built at May, Harden and May's yard on the

Thames – a business owned by the Aircraft Manufacturing Co. We lived at Southampton for quite a time. This flying-boat may be justly called the progenitor of all Supermarine boats.

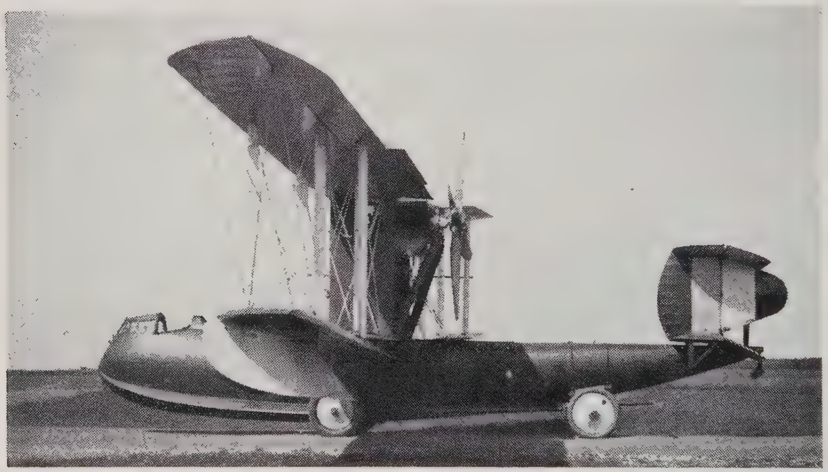
'When we arrived at Woolston, P.B. proudly showed us his Zeppelin strafer which, if I recall correctly, was a large quadruplane with guns right on top. Before that there had been what they called the Push-Proj – a little single-bay pusher biplane designed as a rival to the D.H.2, and though I never saw this machine I associated it with the work of Harold Bolas.'

Developed from the original 80 hp Push-Proj P.B.23 was the sweptwing Monosoupape-powered P.B.25, of which 20 were ordered by the Admiralty. Its relatively low drag resulted in 99 mph compared with 93 mph for the D.H.2. (*H. Busteed.*)

Frank Cowlin added his comment that: 'It was the practice at the Air Board to turn out a complete and final set of drawings as a basis of contract, and I certainly learnt what tremendous work this involved. I also learned a great deal about hull design from Linton Hope, who joined the section for a time while we were engaged on the A.D. flying-boats.'

For these two-seat patrol aircraft, Lieut Linton Hope, RNVR, MINA, a great yacht designer, was developing a hull very similar to the flexible, semi-monocoque construction displayed by Noel Pemberton Billing for his P.B.7 single-seater at the 1914 Olympia Aero show, and subsequently used for his larger flying-boat which had a detachable hull. Basically the new A.D. flying-boat was designed by Harris Booth, and Linton Hope had the specialized task of the hull itself, based on racing yacht construction of double diagonal mahogany planking with fabric between, formed over a mould in conventional ship practice, and closely timbered with $\frac{1}{4}$-in rock elm strips to form almost circular ribs 2-in apart, longitudinally stiffened with close-spaced, narrow stringers. The double-bay wing structure with shorter lower wing accorded with practice of the day, but was unique in hingeing at the centre-section front spar so that each pair of wings could be

folded forward instead of back to avoid fouling the biplane tail which had a short lever arm in order to keep the hull compact. Though the fins were large the twin rudders were unduly small. Instead of the proposed Sunbeam Nubian, which was suffering teething trouble, a 150 hp Hispano-Suiza was used, mounted on a pyramidal structure so high, to get propeller tip clearance, that the cylinders almost touched the top wing.



The porpoising prototype A.D. flying-boat No. 1412 had a Linton Hope hull built by May, Harden & May. There was a semi-enclosed bow cockpit, later scrapped to improve Lewis gun field of fire. (*H. Busteed.*)

It was Linton Hope's contention that stressed-skin hulls were stronger, weight for weight, than the Curtiss H-type flying-boats being imported from the USA by the Admiralty for active experimentation by Commander John Porte – that major driving force in the British Deperdussin Co which had been managed by M. Santoni with Koolhoven as designer until liquidation prior to the war. Built on a conventional framework of longerons and struts, the Curtiss was basically an attempt to attach a flying-boat fore-body to a conventional fuselage girder which proved particularly weak and unseaworthy, necessitating strengthening with additional planking, and resulted in increased tail heaviness. Scathingly, Porte's naval architect assistant, David Nicholson, later commented: 'The Curtiss boat, with twin engines, built in the USA, was probably the worst example of boat building that could be imagined, for it had no less than four consecutive planks butted – not even scarfed – on the same timber, which had a siding of only $\frac{5}{8}$-in, the line of butts being in line with the step, where the boat was naturally weakest.'

The first Curtiss hull to arrive was No. 950, the *America* Boat – one of a pair ordered by Murray Sueter at Porte's instigation before the war, and delivered to the new seaplane station at Felixstowe in November 1914. Step by step alterations were made to analyse fundamentals affecting take-

off, sea behaviour, and landing impact. Originally it was wall-sided, devoid of projecting side chines to the front step and planing bottom, and to remedy difficulty in getting off the water the breadth was increased by adding these parts. They proved insufficient, so Porte added fins, but the boat failed to run cleanly, shipping water because the short nose gave insufficient forward buoyancy. A new hull was therefore built, affording a longer planing surface, and the step was moved further aft. Unfortunately take-off was worsened – due, it was found, to suction from the convex surface of the submerged rear portion of the hull. A few alightings on the choppy waters around Felixstowe made it obvious that the hull was of too light construction, but Porte persevered with a programme of remedies.

By contrast, White and Thompson boats were backed by the long motor-boat racing experience of Saunders of Cowes, who built their hulls. Though excellent performers, the multi-skin sewn construction nevertheless proved disappointing because the wire sewing, sunk flush with the surface of the outer skin, cut into the soft cedar when the boats were subjected to severe landing shocks – and further trouble was experienced due to the combination of a semi-flexible hull structure with a series of rigid bulkheads, resulting in distortion.

In Britain the Curtiss H-12 was named the Large America and fitted with 250 hp Rolls-Royce engines. Essentially a calm-water machine, its deficiencies led to Porte's redesign as the F-series. (*T. Elsemore.*)

Linton Hope, the arch-critic of both Curtiss and the White and Thompson designs, said that when he joined the Technical Department of the Admiralty in 1915 he had no experience of flying-boats though for some years had made careful study of hydroplanes. He was astounded to find how heavy and badly built was the Curtiss *America*, and decided she was a very poor hydroplane owing to the form of after-body and enormous wetted surface. His outspoken criticism was accepted in none too friendly spirit by Porte, whom Hope regarded as 'a complete amateur, both as a naval architect and boatbuilder, but it is marvellous that he succeeded in developing flying-boats until their lifting ability increased some six times that of the original *America*.'

Hope's collaborative venture under the guidance of Harris Booth, took the form of three basically circular-section hulls of outstanding streamlined

form, though the tandem cockpits were open and too far forward compared with the cabin of the Curtiss-Felixstowe type boats. Because of his racing hull designs he was able to make an amazingly accurate weight estimate, for they were only a few pounds over the target of 430 lb.

The Sparrow was characterized by an enormous tailplane and a pilot's position which gave a superb all-round view. Two were intended from Blackburn and two from Hewlett and Blondeau of Leagrave, Beds. (*Courtesy National Aviation Museum, Ottawa.*)

Harris Booth had also initiated the preliminary landplane design for a small anti-Zeppelin fighter using the Davis recoilless quick-firing gun which the Admiralty was developing, and gave the prototype to the Blackburn company to build. Known as the Sparrow, this 30 ft span pusher biplane was even more unconventional than Pemberton Billing's attractive Push-Proj P.B.23 which had proved unstable due to excessive rearward C.G., and was currently being rebuilt with sweptback wings. As though with this lesson in mind, Harris Booth's fighter was given excessively large tailplane span to compensate for its short lever arm – but as the nacelle was attached to the top wing, the high thrust-line foreshadowed trim problems. Because of night landings the undercarriage incorporated skids, and the wheel track was made only $2\frac{1}{2}$ ft on the assumption that if accidentally landed one wing down the machine would not slew so readily as with wider track. Some thought that much learning had made Booth mad – though this was not Robert Blackburn's early opinion as a favoured protégé.

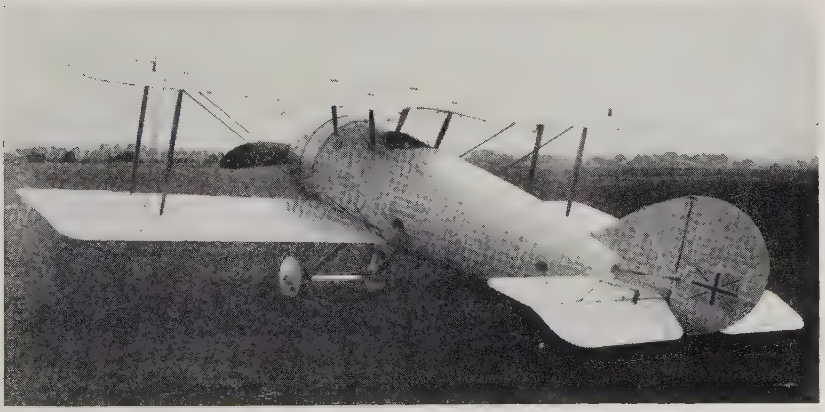
2

Although the Navy had spread its requirements across practically the whole aircraft industry, by far the biggest contracts were from the Department of Military Aeronautics of the War Office to match the vast land offensive. Standardization of the B.E.2c effectively eliminated production of all Trade two-seat front-line aircraft except the Vickers F.B.5 as the paramount defensive fighter protecting reconnaissance machines. Even the D.H.1 was disregarded. On 25 July No. 11 Squadron RFC arrived in France with their Vickers armed pushers, and a few F.B.5s were also allotted to other squadrons. Pilots liked them immensely, for not only did their

As an example of determined development from successive pusher fighters of which the first was designed by A. R. Low, the Vickers F.B.5 was put into production as a private venture at the beginning of the war. Prototype illustrated. (*Vickers Ltd.*)

appearance give an impression of rugged strength but they were easy to fly. Quickly the F.B.5 became the general purpose machine of the RFC, rather than purely for fighting, undertaking long-range reconnaissance, photography, and artillery observation flights. Maintenance reports received at Vickers revealed splendid reliability except for difficulty with the Monosoupape engine. Looking into the future, Rex Pierson completed the design of an armoured adaptation for trench strafing, powered by the first 110 hp Clerget engine received in England from France. A further development on his board revealed a cleaned-up version with V-undercarriage and rounded wing-tips instead of square.

Pierson had also redesigned Harold Barnwell's Bullet single-seater, now called the E.S.1. Tested by Barnwell, a startling speed of 114 mph at



The E.S.1 was sufficiently early in 1915 to have the 1914 Union Jack insignia, but this was replaced with the tricolour before Service trials. Lack of cowling louvres led to cooling difficulty, and the undercarriage track was too narrow though the span was only 24½ ft.

5,000 ft was recorded using a 100 hp Monosoupape – far faster than any machine then flying, and second only to H. P. Folland's S.E.4 from the Royal Aircraft Factory stable, which had attained 135 mph but was abandoned because of inferior handling qualities, particularly when landing. So advanced was the E.S.1's performance that the little fighter was immediately flown overseas for Service trials – but RFC pilots were not enamoured, largely because the wide rounded fuselage and low placement of the pilot relative to the unstaggered wings severely curtailed downward view. Presently it was crashed by Capt Playfair. However, Vickers felt sufficiently encouraged to build a second version during August, designated E.S.2. A cut-out centre-section trailing edge gave better upward view, and narrower fuselage fairings somewhat improved the downward vista. For simplicity the underside of the fuselage was flat, and to give even greater performance a 110 hp Clerget was fitted, but the machine proved heavier and slower.

The Vickers F.B.7 (illustrated) had Monosoupape engines and the pilot was in the rear cockpit, but the production F.B.7As had revised wing structure and fuselage, 80 hp Renault engines and the pilot ahead of the wings. (*Vickers Ltd.*)

Meanwhile their chief designer, Howard Flanders, was in trouble. His twin-engined F.B.7 had been completed at the end of July. Its two opposite-handed Gnomes were on overhung mountings each side, located midway in the gap on pyramidal steel bracing struts top and bottom, with a single stabilizing strut at the rear. Though spanning 16 ft more than the single Isaacson-powered biplane Flanders built for the 1912 Military Trials competition, the family likeness was evident. A similar pentagonal-section forward portion of the fuselage blended into a triangular-sectioned rear carrying an Avro-like balanced rudder, and the two-bay unequal span and chord wings carried kingpost-braced extensions. Both designs had low-slung wide-track undercarriages with central skid.

When Harold Barnwell made the initial flight early in August he landed somewhat dismayed, for the machine was laterally uncontrollable. Typically, Flanders immediately lost favour with Capt Wood, the managing director. Heated words were exchanged, and Flanders was transferred to

development of the fourteen-cylinder Hart radial engine which was being financed by Vickers. His machine was flown to the Central Flying School handling flight at Upavon, where the test pilots condemned it as 'a horrid machine'. Subsequent experience revealed that the F.B.7 was suffering aileron reversal due to undue flexibility of the overhang; so Pierson was given the task of stiffening the wing structure as well as adding front bearers and structural nacelles to strengthen the engine mountings. Before the end of the month the usual skilled salesmanship of Major Bertie Wood successfully secured an order for 12 production aircraft.

At this point Rex Pierson was appointed chief designer, with Harold Barnwell collaborating happily with him in this work. Challenger, despite his great success in designing the pusher F.B.5 developed from Archie Low's E.F.B.1, was rather too old to keep pace with the new eager generation in the drawing offices, and was appointed 'adviser' to Bertie Wood, though was never happy in this work.

Pierson now began further redesign of the F.B.7, employing a conventional rectangular-section fuselage in which the pilot's cockpit was changed from abaft the wings to the nose; and two 80 hp Renaults were substituted for the Gnomes. As the Vickers shops at Crayford were in full production with F.B.5s and the extensive new premises at Brooklands was earmarked for B.E.2c construction under the management of de Havilland's old assistant, Frank Hearle, it was decided to sub-contract the F.B.7A to the British subsidiary of the Darracq firm.

Rapid though production of the Vickers F.B.5 had become, other firms were no less effective with their war-time effort. Thus the second-line Avro 504 was being produced in even greater number, and to meet requirements A. V. Roe had recently sub-contracted a batch of 50 to S. E. Saunders whose long boat-building shed up the Medina also gave adequate room for 30 Short 184 seaplanes to Admiralty order.

A. V.'s brother Humphrey Roe, as managing director, had been furiously arguing against a decision of the Department of Military Aeronautics to cancel further production of the 504 so that full manufacturing capacity could be devoted to B.E.2s. Although the 504 had achieved many initial bombing successes it was considered outclassed by the latest B.E.2c with RAF 1a engine, which had slight superiority in speed, payload and climb – matters of vital importance on the battle-front where a few miles an hour or a minute saved in climb could make all the difference between safety and disaster. Yet handling qualities of the 504 were so good that Naval and RFC pilots were glad to find other uses for it – particularly training and anti-Zeppelin patrols. With a 504 Commander Bigsworth had succeeded in climbing above a Schütte-Lanz airship at 10,000 ft, and dropped four 20 lb bombs on it, Though they failed to explode the hydrogen, the airship was damaged seriously enough to force it down at Évère, where it was wrecked. To improve the Avro's chances it was decided that night attacker versions would be single-seaters carrying sufficient fuel to remain airborne for 8 hours. Known as Type 504C, they had an aperture in the

The Admiralty ordered several versions of the Avro 504, all of which had stiffened spars, wide-span ailerons, and large vertical fins. The 504B (top) and 504C (centre) had cut-away sides to the rear cockpit and the 504E (bottom) had the pilot further aft and the wing stagger reduced to compensate. (*Photos. Courtesy The Royal Aeronautical Society* (*top*) *and R. E. Nicoll* (*bottom*).)

centre-section enabling a Lewis gun to fire upward at 45 degrees. Meanwhile another version known as the 504B was similarly built with stiffened spars, long fin, and pylon-type B.E. tailskid, for use by the RNAS as a trainer.

Of this period J. R. 'Jock' Ratcliffe recorded: 'Because of their increased design requirements, A. V. Roe & Co Ltd were advertising in the *Manchester Guardian* for draughtsmen, and as I had just left The Municipal School of Technology at Manchester, where I had a Bolton Scholarship, I applied, and was engaged by Mr Roy Chadwick at a salary of 45/- per week, starting work on the 14th June at their Clifton Street works – a back-street of Newton Heath, Manchester. My letter of engagement, dated 1st June 1915, was signed by the managing director, Mr H. V. Roe, who was responsible for the clerical and financial side of the business. John Lord, who had operated the "Bullseye bracer" business for him, became his assistant.

'There were ten or twelve draughtsmen in the drawing office, each responsible for his own detail stress work. Chadwick virtually carried out the functions of chief draughtsman, chief stressman and chief aerodynamicist, but he had a very capable assistant, Mr F. W. Vernon, a Whitworth scholar, who carried out the main stress work on wings, and I think was the first at A. V. Roe's to base these on the Theorem of Three Moments with adjustment for bracing wire offsets.

'Production was controlled by Mr R. J. Parrott, the works manager, who was a good all round engineer, and previously was chief draughtsman at their original works at Brownfield Mills, where Chadwick was initially his assistant, though H. E. Broadsmith now occupied that position.'

Twenty-five-year-old Harry Broadsmith had joined A. V. Roe Ltd, in 1912 as a draughtsman, after apprenticeship at the Lancashire and Yorkshire Locomotive Works and subsequently as a marine engineer on the Furness Withy Steamer Line for several voyages to South America and West Africa. As a loyal north countryman, like Chadwick, he had keenly followed A. V. Roe's flying efforts, but it was through a letter of introduction from the Hon Maurice Egerton that he managed to buttonhole the mercurial A. V. for a job. Early in 1914 Broadsmith became outside representative at Brooklands, but when war broke out he returned to the Manchester works as night-work foreman-in-charge. His present job was to build up facilities for extended production.

The Avro technicians, led by Chadwick, were currently redesigning the Avro 510 seaplane, originally built for the *Daily Mail* Circuit of Britain seaplane race of 1914 where Broadsmith was to have flown as mechanic with Raynham as pilot. The new 519, though geometrically similar, was larger, and was the result of Admiralty enquiry for a large bombing aeroplane but quickly became superseded by a further Admiralty requirement for a still larger bomber for which A. V. Roe Ltd and the new Fairey Aviation Company were invited to tender twin-engine designs to compete with single-engined monsters which Shorts and Samuel Whites were commencing. Soon Chadwick had outlined a very handsome biplane of 60 ft

Lieut Robert Arthur Bruce, MSC, RNVR, (left) had pre-war aircraft experience at Bristols, became Admiralty Overseer to Sopwith and, later, manager of Petters' Aircraft Department. R. J. Parrott (right) was Avro's earliest draughtsman-designer. He became Works Manager in 1915.

span, with performance calculated on the most powerful engines likely to be available – a modest total of 320 hp, though there was hope that if the machine proved successful it might be repowered with the big engines which Rolls-Royce were developing.

At Brooklands there was a new rival to the Avro 504 and B.E.2c. Sigrist's 'Bus' was at last ready after considerable delay through pre-occupation with production organization and man-power training. The Sopwith shops were full with Admiralty repeat orders for the single-seat Baby, based on Howard Pixton's 1914 Schneider seaplane winner. There were also small batches of the Admiralty Type 807 seaplane and its derivative 'Spinning Jenny', and the big but not wholly successful Type 860 seaplane: while at Brooklands they were rigging and flight testing a number of Type 805 Sopwith Gunbuses which had been sub-contracted to Robey & Co of Lincoln.

The success of Sigrist's 'Bus' was immediately emphasized on 6 June, when Harry Hawker climbed the machine from Hendon to a corrected standard atmosphere height of 18,293 ft. C. G. Grey recorded: 'On Sunday Mr H. Hawker established a new British height record, the first we have seen for many a long day. A week previously he made an attempt on a Schneider-Sopwith at Brooklands, but on reaching the "Archibald-proof" (anti-aircraft gun) height of 11,000 ft was so cold that he gave up. This Sunday, however, he was entirely successful. He flew from Brooklands to Hendon shortly before lunch in a new 80 hp Gnome Sopwith, which had only been completed the evening before, covering the 21 miles in 13 minutes, and at 4.15 started up in very bumpy air. In $1\frac{3}{4}$ minutes he was at 1,000 ft in a blue sky. In 20 he had reached 10,000 ft and everyone at Hendon had a stiff neck from watching. The Sopwith dodged around the light fleecy clouds, getting more and more like a tiny gnat, and at last vanished. An

hour and a half after Mr Hawker ascended, his machine was suddenly discerned on the northern side of the aerodrome nearing the ground. When almost on the grass he started his engine again, and made several circuits at a speed of 90 mph. When he landed it was found that the limits of his sealed barograph, which only registered up to 20,000 ft had been exceeded, and he was accorded an enthusiastic reception on the creation of a new British height record. The last 100 ft took 8 minutes to climb, and the engine, with a specially designed Lang propeller, which gave 1,300 rpm on the ground, had dropped to 1,100 by the time the barograph had reached its limit. The descent took 17 minutes and the landing was perfect. The new Sopwith is a fine specimen of what British workmanship can do, and the congratulations showered on Mr Sopwith and his brilliant pilot were thoroughly deserved. We may look for more Sopwith records in the near future.'

With so promising a performance Tommy Sopwith and his team realized that here was another potential winner, but within a few weeks interest switched to the S1.T.B.P. single-seater for it was ready for flight. Easily the prettiest Sopwith so far built, neither its speed nor climb proved exceptional owing to the minuscule 50 hp of its Gnome. Stability was perfect, and Hawker said: 'It flew like a bird.' On the wave of enthusiasm created by the Sigrist 'Bus', the Sopwith team saw that in the new little 'Runabout' they also had the genesis of a small single-seat fighter which, like the two-seater, might be fitted with Kauper's synchronized gun-firing gear.

As one of the benefits of flying this machine with its forward C.G., Hawker now made several proposals involving alteration to the C.G. of the Sigrist 'Bus', for he was convinced that crew positions must be reversed, with pilot in front and the rear cockpit utilizing the gun ring invented by Warrant Officer Scarff. Practicability was established by fixing a central bar to the undercarriage along which a container holding lead weights

There were no drawings for the Sopwith S1.T.B.P. It was lofted full size in chalk on the floor of the Experimental shop, and instead of the customary bull nose had its Gnome enclosed in a circular cowl like the Bristol Scout. (*J. H. Williams.*)

could be slid to vary the C.G. while flying, and then Herbert Smith was given his first major task of revamping the design with equal-span wings, moving back the lower one to get the equivalent C.G. used by Harry Hawker for his little 'Runabout'. The latter's type of cantilevered rear engine mounting and circular open-fronted cowling were also adopted for the proposed 110 hp Clerget of the new machine.

August saw a much bigger single-seater than the Sopwith under test at Brooklands – the long-range general purpose Martinsyde G.100 largely designed by Tony Fletcher, MA, the star pre-war apprentice of Handley Page, who had been stressman to Handasyde since 1914. Dimensionally the new machine was a direct revision of the unwanted two-bay trainer structure, replacing the Anzani with the much heavier 120 hp Beardmore 'vertical' and extending the fin to compensate for the longer nose. Sparing allocation of the small earlier S.1. single-seater in ones and twos to several squadrons on the Western Front and in the Middle East had turned Handasyde's thoughts towards a scout with advantage of greater duration than the agile little Sopwith which he had watched on test at Brooklands. The result was a much less handy aeroplane spanning 38 ft, but handsome as were all Handasyde's conceptions, and having something of the appearance of a single-seat B.E. with car-like nose and three-blade propeller. Pilots reported sufficiently favourably on the advantage of its 5½ hr duration for an order of 50 to be placed – despite heavy ailerons and criticism of undue floating if brought in to land a little fast.

The Martinsyde G.100 prototype at Brooklands in September 1915, showing the three-blade propeller for its 120 hp Beardmore. Large duralumin flitch plates attached the centre-section struts to the fuselage which was locally ply covered. (*H. Busteed.*)

While production was being established, Fletcher proposed and stressed a revised G.100, with 32 ft span single-bay wings substituted for the production two-bay wings. At this point the easy going but sometimes obstinate Fletcher got at loggerheads with his irascible employer over a breakage for which his stressing was blamed and abruptly left, joining the London and Provincial Aviation Co Ltd owned by Messers Warren and Smiles who were just transferring their Hendon flying school to nearby Stag Lane. Concurrently Handasyde appears to have adopted Fletcher's

small span version of the G.100, beginning a prototype using a slightly modified production fuselage and tail with intention of fitting a 150 hp Hispano-Suiza. It is possible that Fletcher had already ordered one from France, for he spoke fluent French, and power units had his interest as he was an expert on propeller design.

3

Issue by the Advisory Committee for Aeronautics of its Report for 1914/15 was a timely reminder of ever-extending research undertaken by the Royal Aircraft Factory and the National Physical Laboratory. Recent aerodynamic investigations with wind-tunnel models embraced airships, airship appendages, aeroplanes and individual wings, bodies, fins and rudders, tailplanes and elevators, struts, wires, and undercarriages. While most of the research was *ad hoc*, much was at the request of the Admiralty and War Office to obtain basic information leading to future improvements in design, construction, and ability to meet specific military requirements.

Ever deeper probing had continued on stability of aeroplanes, particularly in the case of a machine turning in a horizontal plane or spiral path – for which analysis involved solution of algebraic equations of the eighth degree. Simplified methods of calculation had therefore been developed. Valuable information resulted which related the influence of turning on longitudinal stability, and on the tendency to spinning instability known as a spiral dive. Increasingly work of this nature was complemented by full-scale investigation to correlate with model work and mathematical prediction.

Enquiry into factors affecting the strength of aeroplanes and methods of calculating stresses in wings and bracing had been extended to more rigid structures by developing the theory of 'strain-energy'. Reports from the Expeditionary Force had particularly indicated the need of increasing attention to good construction in detail design. All machines currently being designed now targeted higher margins of strength than the standard requirement, based on considerations of recovery from a steep dive. However, Farnborough technicians realized that: 'Increase in strength has to be considered in relation to other factors affecting safety – in particular the merit of rapid climbing which lends safety of a different kind and limits the increase in strength and weight which otherwise might be judged desirable.' Aeroplanes had also become safer because it was now possible to make them inherently stable without sacrifice of controllability.

C. F. Caunter in his historical summary of the Royal Aircraft Establishment recorded: 'Parallel with this considerable investigation into the fundamental problem of aeroplanes and engines was a great supplementary volume of effort directed to the design of ancillaries and auxiliaries of all kinds. This included such items as preparation of non-actinic fabric dope for both airships and aeroplanes; metallurgical problems of all-metal fuselage structures; evolution of the first practical aeroplane compass; streamlined bracing wires; variable-camber wings and flaps; air-brakes; bomb-sights; cockpit instruments; navigational instruments; and special

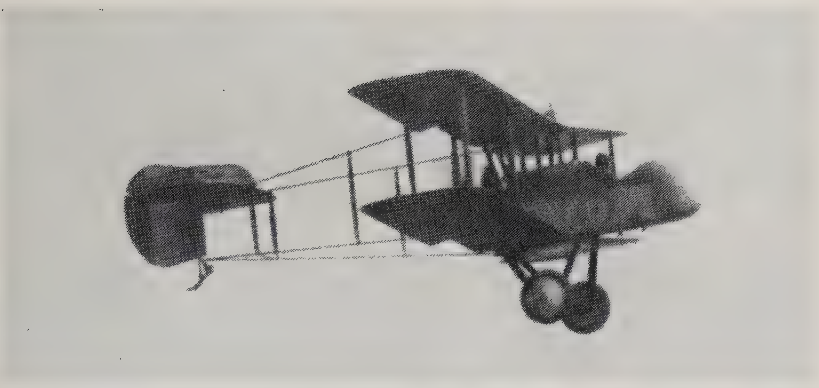
instruments for full-scale and wind-tunnel research work; variable-pitch propellers; development of tooled steel for exhaust valves; liquid cooling for valves; special light alloys for pistons, cylinder heads and cylinder barrels; supercharging of aero-engines; oleo undercarriages; automatic remote control of aircraft; A.G.S. standards; and the inauguration of inspection methods and services for aircraft and engines.

'With characteristic energy and enthusiasm Mervyn O'Gorman built up this establishment from small beginnings which had existed upon his arrival, to what had become a national centre of scientific aeronautical research and development supplying the greater part of the knowledge that was required to produce efficient aircraft. The Royal Aircraft Factory, no longer restricted by meagre grants, had expanded enormously in personnel, equipment and buildings. By the middle of 1915 it had run night and day for the best part of a year under the urgencies of war, and the number of personnel engaged in this process rose to about 4,000, compared with Mervyn O'Gorman's initial 100 in 1910.'

Their spirit of efficient team work was well expressed by J. D. Scott in an unpublished MS entitled *The Royal Aircraft Establishment Organisation and Administration*, prepared for the Cabinet, where he referred to 'A sense shared by all who worked at this factory, of being the leader in a new field of science and engineering. The design and construction of aircraft, at least until 1915, was a task for enthusiasts. . . . At the Royal Aircraft Factory during the period when it was designing and building aircraft, the general enthusiasm was heightened by a sense of leadership. Before and during the First World War, the scientists and engineers at Farnborough constituted the greatest single repository of aeronautical knowledge in the country. To a strong original staff there were added during the war not only a very large number of normal recruits, but also a considerable proportion of the country's leading scientists. As the importance of air warfare increased, so did the factory's consciousness of being a *corps d'élite* in the country's war effort.'

The high days of this war-time summer saw H. G. Wells assuming his proverbial mantle of prophet for readers of the *Daily Express*. 'An aeroplane costs scarcely more than a shotful of big guns,' he wrote, 'if it is lost it means only one or two lives; it would be cheaper to launch 2,000 aeroplanes against Essen than risk one battleship. They could smash that city to bits, and if we lost 1,000 of them in the raid it would still be cheaper in money and lives than the victory of Neuve Chapelle – but until the Germans attempt things on similar scale it is quite improbable that our rulers would try anything so obvious.

'At present 300 miles of Frenchmen and 30 or so miles of Englishmen, and perhaps a score miles of Belgians are confronting 350 or so miles of Germans. But the way to the left is barred by the sea, and the way to the right by Switzerland, and though we have started to go round by the Dardanelles, that seems likely to prove more lengthy than we supposed. There is a way, however, to the rear of the Germans – and that is through



No. 24 RFC Squadron was the first equipped with the D.H.2, which it received towards the end of 1916 and thus became the first single-seat Fighter Squadron. (*Flight Photo.*)

the *air* to the German rear and smash up their munition factories. We could clear him out of the air altogether if we had enough aeroplanes now. That done, with his wonderful artillery blind, his communications can be destroyed, his arsenals can be smashed up, and our army's advance would be robbed of half its difficulties. Every aviator we have in the air now is worth 100 men saved from death below.'

But the *Morning Post* of 8 August printed an account written from British Headquarters which warned: 'Beyond question the most significant happening of the past month has been in the air. One might almost call it the re-appearance of the German airman, but that would convey the impression of absence more complete than has been the case. The German airman has always been in the air, but – under conditions. A recent despatch from the C-in-C made all England aware of the ascendancy our airmen established from quite early in the war; and even during the last two months, in no single instance where plane was pitted against plane could a German success be recorded, even with odds in the enemy's favour. Our planes were brought down by shell-fire, by engine trouble, by accident, but never by superiority of the enemy's airmen. Time after time we chased them back to their lines, or beat them out of the air, till the German flyers were forced ever higher for safety, and it became the accepted procedure for a German aeroplane to show its tail whenever our aircraft hove in sight.

'It is not to be expected that a people like the Germans, with their exceptional capacity for producing fine engines, would accept an inferior position in what is likely to prove the most important of the arms of war. So though during the latter months of winter and early spring there was a notable deficiency in the enemy's airmen, we understand by the ineradicable German inclination to boast about the future, that experiments are being made with new types of engine and machine which will result in something superior to any craft that has ever taken the air.'

The prophecy was coming true, for the German Luftstreitkräfte was beginning to show lethal ability at shooting down Allied aircraft. The new

Morane-like single-seat Fokker E.I monoplane was being reported for the first time about the end of July as 'spitting bullets through the propeller'. Here was the first quick result following that fateful discovery of armour-plate deflectors on Garros's propeller. Fokker, and his technicians Leinberger and Lübbe, had beaten Kauper and other British engineers by devising an effective cam-operated mechanical gear which caused the propeller to fire the gun instead of a system stopping emergence of a bullet when the propeller blade was in the way. Tested by the ace German pilot,

The Fokker E.I, with 80 hp Oberursel, was frequently mistaken for a Morane-Saulnier. The E.I shown here was being demonstrated by Buddecke. The machine used by Oswald Boelcke was E36/15

Oswald Boelcke, it enabled him to shoot down an Allied machine on his third flight with the new Fokker. The next machine with this gear went to the redoubtable Max Immelmann, and within three or four weeks half a dozen more were flying at the front, picking off French and British with devastating ease. The only Allied machine likely to match it might be the new D.H.2 pusher which was rushed into production during August, practically unchanged from the prototype except for increased balance to the rudder and a gravity fuel tank fitted to the root of the port upper wing. The Farnborough-designed competitor, the F.E.8, could not be ready even in prototype form for some months because the small project team in John Kenworthy's charge had only begun working on it in May – but preliminary drawings showed a speedy looking biplane 3 ft greater in span than the D.H.2, with tail-booms vee'd in elevation instead of plan. Designed to weigh 100 lb less than the D.H.2, it was expected to have better climb. Meanwhile successes of the Fokker increased and increased – until every newspaper bitterly proclaimed that British pilots were 'Fokker fodder', and questions were raised in the House.

C. G. Grey leapt at this opportunity of aiding the aircraft industry by attacking the Government's handling of air affairs and particularly use of the B.E.2c. When Clarence Winchester supported its selection with an article in *The Times Engineering Supplement* that September, C.G.G. called him the *advocatus diaboli* of the Royal Aircraft Factory, though Winchester was scarcely contentious in declaring: 'The policies of effort for quantity,

and the equivalent for the "latest thing" are opposed. The "latest thing" must be slowly and cautiously made in ones and twos and tried in tens or twenties, first at home and then abroad. Large and quick production implies complete acceptability of the type; it implies launching out with special tools of great precision for rapid mechanical operations to diminish the drain on manual labour; it implies one identical product for repetition. Perspective is required to deal with such proposals, and perspective is to be got by leaving the crowd and looking on the situation from some detached eminence.'

Bitterly C.G.G. commented that the roof of the Royal Aircraft Factory's new managerial offices was neither sufficiently detached nor sufficiently eminent to make the view thoroughly commanding. He declared that if less attention had been paid to the advice of so-called 'experts' in government employ and more notice taken of rule of thumb engineers who had studied the aeroplane ever since first made, then a good many lives might have been saved.

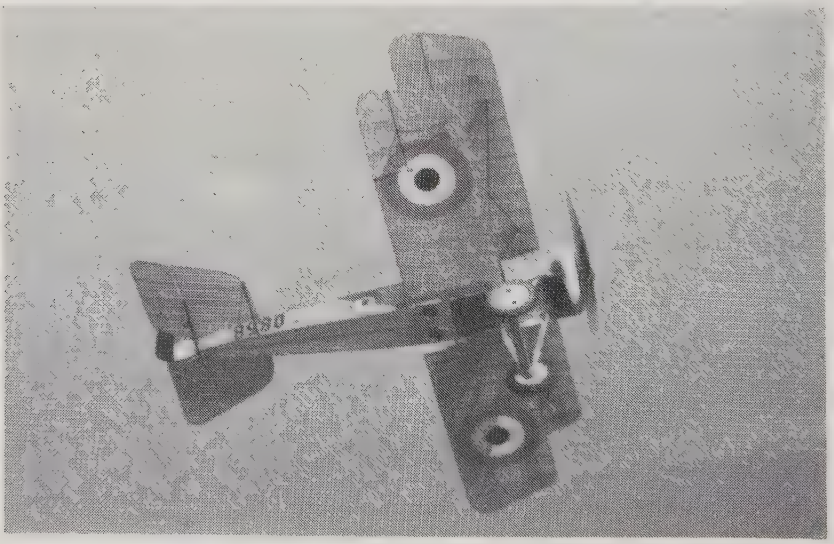
But criticism could also be levelled at naval air affairs. Changes were currently being made. Admiral Vaughan-Lee had been appointed Director of Air Services in the Royal Navy, in place of the dictatorial Commodore Sueter who was side-tracked to the new office of Superintendent of Aircraft Construction although he was the founder organizer of naval aviation. Sueter's personal administration had extended to so many departments that it was impossible to do justice to each. Law, order, discipline; design, construction, supply of materials; strategy, tactics, manoeuvres on active service; organization, provision, and home defence: all had been his sphere of vigorous action, for he was of the old school, unwilling to delegate any section of his duties to other officers. Indeed, few had his competence and vital appreciation of air warfare.

'Now that he can concentrate on the supply of aircraft,' wrote C. G. Grey with inside knowledge of secret Admiralty procurement of the O/100 and A.D.1000, 'we want long-distance aeroplanes capable of bombing the German air stations, such as Cologne and Düsseldorf, and we want machines which fly and climb faster than anything in Germany. Given a free hand, British aeroplane constructors can produce them, but not if time and shop space is wasted on weird theoretical designs by Government employees, nor if their own designs are altered and re-altered by theorists with practically no personal experience of flying or construction; nor if their output is dependent on the whims of people with power to scrap work without knowledge of whether it should be scrapped or not. The whole system of supply for the RNAS needs reorganization until all the weeds are wiped out, down to the most insignificant and inefficient RNVR inspector.'

Whatever the difficulties of Service inspectors there could be no doubt of the value of the great and intelligently discriminating Aircraft Inspection Department which Lieut-Col J. D. B. Fulton, CB, RFA, had founded and was now transplanting from Farnborough to new headquarters at 13 Albemarle Street, London. To him more than anyone except Mervyn

O'Gorman, British aviation owed its supremely high technical standard. His genius for invention had led to patents for improved field guns, and from the proceeds he purchased a Blériot in pre-war days which he was permitted to house at Larkhill on Salisbury Plain – thus establishing the earliest British military aerodrome. As the first British officer on the active list to achieve a pilot's certificate, No. 27 on a Farman, he commanded No. 1 Aeroplane Company when the Air Battalion of the Royal Engineers was formed, and in May 1912 was posted to the newly formed Central Flying School as instructor in charge of workshops, raising the mechanical side of the RFC to the same heights as the administrative achievements of his adjutant colleague, Major Trenchard, DSO, with the result that in December 1913 the War Office made him the first Chief Inspector of Material RFC, rewarding his services with a CB. Inevitably when the Aeronautical Inspection Department was formed in 1914 it was placed under his control, and he was gazetted temporary Lieutenant-Colonel. In this great vocation of ensuring that RFC and Naval aircraft were to the highest possible standard he was loyally assisted by his former fellow flying experimenter, G. B. Cockburn, who had responsibility for airframes, and by Capt Bagnall-Wild, RE, in charge of engines.

When it came to testing and passing production aircraft the AID steered a tactful course between manufacturer and Service pilot. Contractors delivered wings, tails, and fuselages by road or rail to stipulated aerodromes or seaplane stations where their own staff erected them and then handed over to the AID who had full responsibility for flight clearance and tuning



The Bristol Scout D appeared late in 1915, and had shorter ailerons and increased dihedral compared with earlier versions. Later machines had the 100 hp Monosoupape. One RNAS Scout was carried aloft on a Porte Baby and made a mid-air separation. (*H. Busteed.*)

and testing by experienced RFC pilots seconded to them though not under their disciplinary control. It had its problems. Thus at Gosforth there were undercurrents of difficulty created by Koolhoven's overbearing temperament. A battle was waging on the technical standard of his production machines. The big Dutchman had virtually told the AID to go to hell! At this Capt A. P. Thurston, DSC, RFC – that one-time assistant of Hiram Maxim now responsible for design safety of Service aircraft – wrote to the chief inspector: 'General McInnes's rulings are attached. I brought your difficulties before the General to-day, and he wishes to inform Armstrongs that there must be no further questioning of AID decisions except in writing to me. The General stated that Lieut Hammond is to remain there to test machines and telegraph pilots when machines are approved. AID is to give General Caddell plenty of warning of aircraft ready to fly away. The General further stated that he holds me responsible for the safety of the design of all machines except those of the Royal Aircraft Factory for which he accepts responsibility. This will greatly increase the importance and duties of the AID. I shall be glad if you will provide the necessary staff to discharge these additional duties. A. P. Thurston.'

4

In October semi-militarization of the Royal Aircraft Factory staff was decided upon. Senior scientists were offered military rank, and Mervyn O'Gorman, as officer in charge, was commissioned Lieutenant-Colonel. With 1,600 volunteers from the Factory, the Hampshire Aircraft Parks RFC (TF) was created, establishing mobile repair units so that, if and when an advance was made in France, they would be available to service aircraft in the field.

Now rapidly approaching 5,000 on its pay roll, the Government's Factory had become easily the biggest single aircraft unit in the country. Many considered the number of employees fantastic for a research and design establishment building occasional prototypes; but they overlooked the great volume of detail equipment passing through the workshops. The value of Farnborough's contribution was indicated in a letter written by Colonel Brancker to Lieut-Col O'Gorman: 'By your efforts, in spite of our deficiency at the beginning of the war, the Royal Flying Corps is now equipped with all essentials.' Nevertheless, fighting power had been restricted to a few Bristol Scouts and Martinsydes equipped only with guns set obliquely clear of the propeller, or mounted high above the pilot to fire over the centre-section. Only in the last few months had the pusher Vickers F.B.5 two-seater become active in squadron strength. The very day No. 11 Squadron took its new Vickers fighters to war there had been a relatively rare sequence of three fights with German two-seaters, by Capt Lanoe Hawker flying a Bristol Scout armed with a make-shift arrangement of a single-shot cavalry carbine mounted obliquely on the starboard side of its fuselage. Although Fokkers were picking off isolated flyers, it was found during the great French attack in Champagne during September, while the British staged a subsidiary offensive at Loos, that both Allied and hostile

aircraft could still make reconnaissances without over great risk of air attack, although 'Archie' * and small-arms ground fire brought many down. It was then that for the first time the French used *Corps Escadrilles*, comprising specially picked aircraft units trained to co-operate with heavy artillery, and often patrolling some miles behind the German lines. Double-headed columns in the Press glowingly described joint advances by the British at Lens, and the French on their right at Souchez – though not unnaturally the official communiqués from the British Army HQ made much less of French successes than the capture of Loos and Hill 70 by the British in their move forward of some two miles on a five-mile front.

Although at the beginning of the war both the Allied and enemy conception of using the sky went no further than the value of gun-fire observation and location of ground forces – for which purpose slow-flying aircraft were deemed best as they gave time to view the ground – by mid 1915 German aircraft design had become more flexible and imaginative than the British, and not only had produced a damaging fighter in the Fokker but was tending towards adequate armament for two-seaters. True, only recently had the Etrich Taube monoplane been withdrawn from the Front, though on 30 August one had dropped five small bombs on Paris and added a message calling the city to surrender. Their new C-class tractor aeroplanes currently made the B.E.2c obsolete by installing the observer in the rear cockpit, like the still unfinished Sopwith, and giving him a movable gun ring which enabled the new Parabellum – a lightweight form of the Maxim with fretted recoil casing – to be traversed simultaneously with change in vertical angularity. Typical was the Rumpler C.I, regarded both by users and opponents as an outstanding flying machine. Its rotatable gun mounting had been designed by Schneider, the Swiss designer, whose 1913 interrupter gear was fitted to a special demonstration monoplane at the end of 1914 and eventually assessed for suitability simultaneously with the Fokker gear. Although Schneider's mechanism was turned down, he had

*Nickname for German anti-aircraft fire derived from the ribald song *Archibald, Certainly not!*

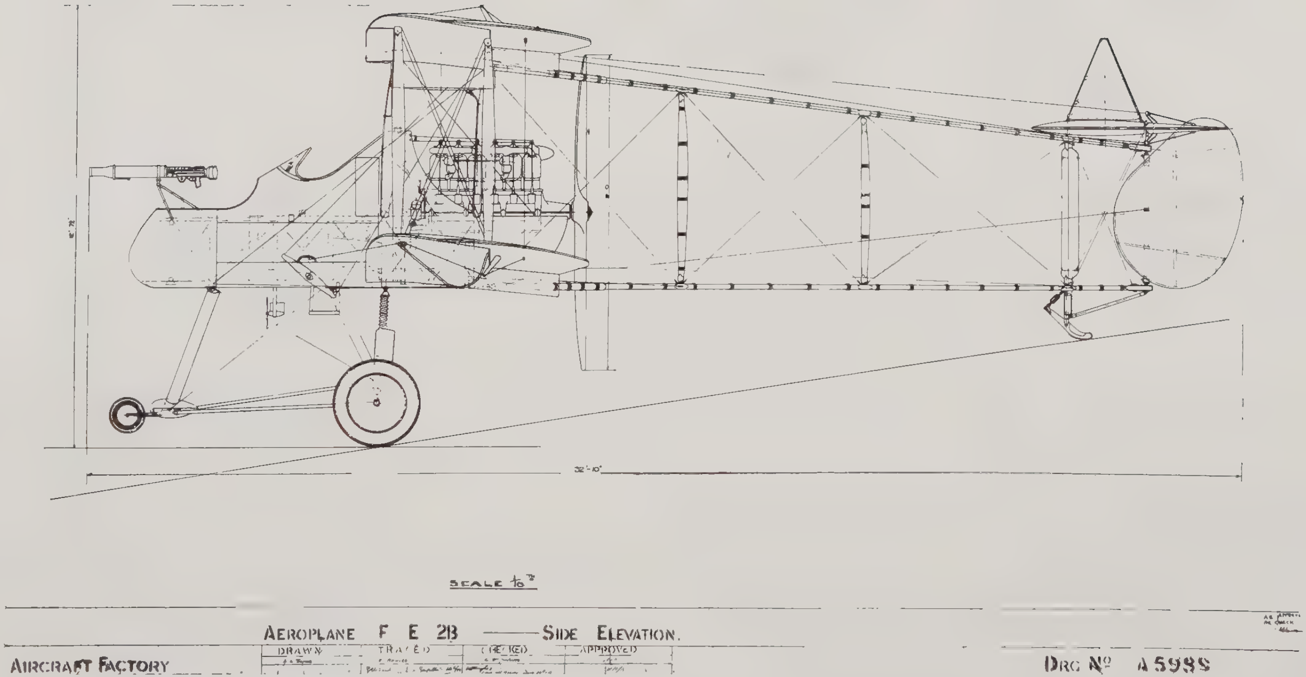
Outstanding among 1915 German two-seaters was the Rumpler C.I with semicircular radiator at the cabane. The gunner had a Parabellum gun on a Schneider ring mounting. A few were still operational early in 1918. (*G. Quick.*)

installed an improved sighting device for the observer, and this was accepted. While the single-seat Fokkers could still be counted in occasional ones and twos, the preponderant German machines were these armed two-seaters, of which the Rumpler C.I was not alone, for there were the L.V.G. designed by Franz Schneider, the Albatros designed by Ernst Heinkel, and the A.E.G., designed by Georg König, which had introduced the Schneider Drehring gun mounting and Parabellum machine-gun as early as spring of 1915. More formidable in appearance was the rarer Ago, a futuristic-looking pusher with a light wooden fuselage either side of the nacelle instead of conventional high-drag tail-booms; there was also a twin-engined A.E.G. fighter with guns fore and aft which had considerably intimidated British and French pilots, but the latest version was a conversion to light bomber rôle with the intention of raiding England from Metz.

By mid-autumn the Royal Flying Corps was clearly outclassed. Hope could only be pinned on early supply of the Gnome-powered D.H.2 single-seater and the production version of the lumbering F.E.2b now modified to take the 120 hp Beardmore. All of two years and three months had gone since the Government's Factory design was first prepared, for constructional contracts had taken second place to the theme of universal standardization of the B.E.2c for reconnaissance. Not until 25 September had No. 6 Squadron – the first equipped with F.E.2bs – four machines on its strength. By then Boelcke, with the Fokker E.I, had already shot down two further aircraft. At this time the F.E.2b had only a simple spindle nose-gun mounting with universal freedom of action but could not fire rearward. Meanwhile in England, Scarff and Dibovski were trying their new interrupter gear against the one made by Kauper, and it seemed somewhat more promising.

How dependent the war effort was on the imagination of British designers was at last becoming apparent. To ensure that these technicians were properly briefed on the trend of RFC requirements relative to military tactics and strategies, Mervyn O'Gorman convened a conference of the Trade at the Royal Aircraft Factory. It was the beginning of true endeavour to secure effective partnership between government departments and the aircraft manufacturing industry. Operations on the war front had given sufficient experience for RFC Headquarters in France to assess the future course of events with reasonable certainty, and the need to replace the B.E.2c with a more powerful and responsive machine for Corps reconnaissance and artillery spotting had become a firm requirement. They specified that machines of this type must in future be capable of full self-defence against air-to-air attack.

O'Gorman, as so often in earlier years, reassured the industrial designers that although Farnborough was currently engaged on further design work, including modification to the B.E. in hope of meeting operational requirements until newer reconnaissance aircraft were available, the Factory had no intention of competing against privately financed aircraft companies.



Original drawing of the F.E.2b, by A. H. Thomas of the Royal Aircraft Factory who later joined S. E. Saunders Ltd as Chief Designer. (*Royal Aircraft Establishment.*)

The maid of all work – the B.E.2c – managed to fly with two 112 lb bomb overload, bomb-sight for pilot (above vertical guides), Lewis gun on swinging mount, and external drum racks. (*D. F. Woodford.*)

His staff would build and develop prototypes; if these proved successful their production would be for open tender.

Certainly the B.E. was performing valiantly not only in France and the Near East, but at home. In *The Central Blue*,* Sir John Slessor describes the earliest anti-Zeppelin night fighter attempt in 1915, when as a 2nd Lieut he was sent to Sutton's Farm with a B.E.2c carrying four small oblong petrol bombs – but though he located the silver shape of the Zeppelin illumined by the bright lights of London shining through the night haze, the Kapitän-Leutnant easily outclimbed him. 'Finally I lost him altogether in cloud – and then found that I also lost myself. After some rather breathless floundering in the dark sky I hit upon the Thames and followed it westward till I saw the faint L-shaped glow of flares below me. By that time I was at about 10,000 and duly patrolled between Tilbury and Chingford reservoirs until I thought my petrol was getting low, then descended to find that in the hour and three-quarters that I had been airborne, the Thames fog had become really thick. The final approach was somewhat complicated by an enthusiast who thought it would be a good idea to illuminate the flare path from the windward end – just as I dipped into fog level! The result might have been worse. My first operational sortie came to an ignominious but painless end in the turnips by the edge of the stubble at the cost of a wing-tip, an aileron, one V of the undercarriage – and I was one of three out of five aircraft that went up that night to crash in the fog, all without hurting their pilots. I suppose I can claim the distinction of being the first pilot ever to have intercepted an enemy aircraft over Great Britain. But I doubt whether an action has ever been

* Published by Cassell & Co Ltd.

fought by such inexperienced, if enthusiastic, amateurs in the air, and behind the guns and lights, as on that night of October 13, 1915.'

5

Of the problems of re-equipping the RFC, the masses in the United Kingdom knew nothing and cared less, but they were concerned that Lord Derby had been appointed to the new post of Director of Recruiting largely to winkle out those who were shirking. It seemed ominous to some who saw good pay being exchanged for the soldier's pittance. Within a few days the new Derby Scheme was announced, requiring every man between 18 and 41 to register in groups by age. Local committees would then decide who was in starred or unstarred occupations, and groups would be called up as required, unmarried men first. It was not exactly compulsory service, but a system of carefully channelled 'volunteering' particularly suiting the English mind, and would be given until the end of the year to prove itself.

But argument for and against the Derby Scheme became overshadowed by a new, burning indignation in the public mind – for on 16 October a great burst of anger and hate was aroused against Germany when the newspapers printed a small paragraph revealing that an Englishwoman, Miss Edith Cavell, who had been nursing for some years in Brussels, had been shot without trial on a charge of assisting war prisoners to escape. It was a story which shook the world; hitherto women had been thought exempt from penalties applied to men in similar circumstances. Miss Cavell's martyrdom was something that would never be forgotten by that war-time generation, and the story of her nobility and courage in meeting the firing squad was to echo through the years. Inevitably it strengthened British resolve to exterminate the enemy.

Within a few days came another shock. Our Allies the Serbs were in disastrous retreat, the Austro-German forces sweeping round to attack them in the rear. Volunteer ambulance units were rushed from England to help the swarming refugees and the wounded. A combined Anglo-French force was landed at Salonika to push inland in hope of aiding the Serbians, but instead its losses sealed the fate of the Gallipoli expedition. Swiftly Serbia was overrun while its army endeavoured to retreat through the mountains of Albania in order to reach the coast for evacuation by the Allied Fleet. If it was Serbia now, who next?

Newspapers seemed to have become mere instruments of war propaganda and did little to allay widespread apprehension of the even more disturbing steady defeat of Russia despite the hard-fought defence of Warsaw. Every setback on eastern and western Fronts was used as an excuse to urge munition workers to greater efforts, and emphasized that the Germans were showing superior gun-power and availability of shells. Slowly the British were beginning to feel a personal participation in the war, and though the Government now had compulsory powers to force every individual to register, many voluntarily asked to be released from offices, shops, factories,

and farms in order to enlist. As tangible expression of help by the millions of civilians still in the country, some £575 million had recently been contributed to the second War Loan. In a lesser way, many groups of women began to send food and clothing parcels through the Red Cross to prisoner-of-war camps in Germany, or they established canteen services at railway terminals for soldiers on leave.

Following the fall of Serbia the public became convinced that the entire War direction was in a muddle, and that friction between War Office, Admiralty, and civilian Ministers could only mean chaotic effort and disruption of planning. Rumours over Cabinet dissension resulted in the *Globe*, a leading evening paper, becoming the first to fall foul of the Defence of the Realm Act, earning suspension of publication for a fortnight. This was startling, for freedom of the Press had long been a household term, and suppression of news seemed to strike at the core of British freedom of speech. There was outcry for a new look in political leadership, urging the Prime Minister to appoint a small Cabinet of no more than half a dozen with absolute power. This was agreed; but to the consternation and surprise of the layman, Lord Kitchener was excluded, and the new strategic Cabinet consisted of the Prime Minister, Mr Balfour, Mr Lloyd George, Mr Bonar Law, and the Chancellor of the Exchequer Mr McKenna. When it became known that Lord Kitchener had gone to the Near East to review the situation there, new rumours mounted. Replacement of Sir Charles Munroe, the Commander in Gallipoli, by Sir Ian Hamilton added fuel to gossip. Surely this meant withdrawal, with all its implication of more carnage? Meanwhile Kitchener's exact purpose remained unknown.

At least the aircraft industry was encouraged by announcement of Colonel Fulton's appointment as Assistant Director of Military Aeronautics that November – but on the 11th came shocking news that he had succumbed to pneumonia, for there were no curative drugs for the malady then. It was essentially through his efforts that eighteen large shadow factories had been established on behalf of Lloyd George, who was working miracles in settling disputes in the Welsh coalfields where alleged enormous profits of colliery owners was used as excuse to strike for bigger wages. But what Lloyd George could not overcome was the resistance of trade unions to introduction of unskilled labour, and particularly the entry of women in aircraft, vehicle, and munition factories.

In November, delegates from the executive committees of seven trade unions met at Westminster Hall to consider working rules for new entrants in the growing aeroplane industry – for though wooden aircraft of former years were built by a handful of non-union zealots merely because they liked flying machines, now that it was a national matter it became the province of the Amalgamated Society of Carpenters and Joiners, the General Union of Carpenters and Joiners, the Amalgamated Union of Cabinet Makers, the National Amalgamated Furnishing Trades Association, the Organ Builders Society, the Woodcutting Machinists Society, and the Wheelwrights and Coachmakers Operatives Union. Whatever they

decided would be quickly followed by similar requirements from unions controlling the engineering workers, metal-working machinists, and welders.

Unanimously the delegates passed two resolutions. By the first, the Minister of Munitions was informed that trade union members would not be allowed to accept employment where piecework was introduced, but required an hourly rate with work conditions acceptable to the union organization. The second required all proposals for employment of women to be submitted to the combined National Conference of the Executive Committees of the Trade Unions and the Employers Association. Many felt that workers were taking a perilous step enmeshing them in national conscription of labour, with the Front as alternative.

Most woodworkers were typical of carpenters throughout the ages: simple, honest men, who pondered patiently over problems, like true philosophers. But they were jealous of their trade. Skilled joiners and shop-fitters in particular were apprehensive that new entrants would flood the labour market after the war and cause unemployment in their trades. Yet it was companies such as Frederick Sage of Peterborough – advertising itself as 'Specialists in Wood and Metal', and renowned for specialized shop-fitting – who were ideal entrants for wooden aircraft construction.

There were problems also with some of the skilled painters and varnishers, for they were becoming apprehensive over the poisonous nature of certain dopes which it was their task to brush into the fabric covers of wings and fuselages. In the House, Mr Anderson asked the Secretary of State for the Home Department for the number poisoned by fumes of Tetrachloride of Ethane during the current year among those employed in doping or varnishing, and particularly the number of cases ending fatally. The Under-Secretary replied: 'According to information supplied to the Home Office, 19 non-fatal and 4 fatal cases of poisoning have occurred. I may say that adequate precautions are now being enforced by the Factory Department in all works in which the process of doping is carried out.' As a result dopes were under urgent investigation by the Royal Aircraft Factory, where Dr J.E. Ramsbottom had produced the somewhat lethal P.C.10 dope which had been 'specially formulated to resist deterioration through actinic light rays'.

6

Reports from France were emphasizing the widely ranging nature of German aeronautical development. At last it was inescapably clear to the War Office that they must match the Admiralty's vigorous plans for widely diversified aircraft. Reconnaissance, fighting, and bombing must each be treated as separate issues requiring a specific design. No longer was it good enough to rely haphazard on the ability of each aircraft company to envisage probable military requirements and make a private venture machine to suit their ideas and facilities. Operational requirements must be channelled more closely.

To bridge the gap before specialized machines became available, the

Top wing span of the B.E.2e was 40 ft 9 in compared with 37 ft for the B.E.2c, though wing area was less because of the 30 ft 6 in lower wing. Speed was slightly greater and climb worse, although an all-round improvement in performance had been expected. (*Imperial War Museum.*)

Royal Aircraft Factory was trying to clean the B.E.2c aerodynamically by converting it to a single-bay biplane with long overhangs. Every B.E. constructor had been sent the new wing drawings with urgent instructions to build no more of the old pattern. Meanwhile, requirements were laid down for an improved reconnaissance aeroplane based on this B.E.2c redesign, but with the observer suitably armed in the rear cockpit like the German two-seaters.

It was expressive of the new outlook that the British and Colonial Aeroplane Company, usually referred to as Bristols, were now restored to active design participation at the Air Board's instigation in releasing Capt Frank Barnwell, erstwhile designer of the successful Bristol Scout, from active RFC flying duties, and re-attaching him to his parent company, though still as a serving officer. Unkind rumour had it that this was because he crashed so many RFC machines that supplies were running short. His old staff had left, except Whistler and Hearder who were making valiant efforts with the incessant stream of modifications for the long series of B.E.s which the company were still making. Clifford Tinson, Barnwell's chief assistant in pre-war days, but recently of the Admiralty, had just accepted the post of chief designer at Frederick Sage, whose aviation activities had been managed since September by Eric Gordon England, that pre-war designer and pilot of the Bristol company, and lately of J. Samuel White. He and Len Bonnard were designing a big twin-engined fighter-bomber biplane which had the engines mounted well outboard, high in the gap between the wings, and to save drag, two large main wheels were let

into the floor of the fuselage, with auxiliary wheels at wing-tips and nose, instead of using the contemporary strutted undercarriage.

It proved too unconventional a design to secure official support, but because the Germans had appeared with the twin-engined A.E.G. series it seemed essential to have an equivalent or better British machine. Rex Pierson's next replacement design of Howard Flanders' world pioneering Vickers F.B.7 twin-engined fighter was well advanced and scheduled for flight in November, but it was only a light two-seater, whereas the new outlook dictated guns fore and aft. So marginal was the payload within the stressing limits of the light wing loading of those days that nothing could be added, and as in any case there was grave shortage of Monosoupape engines, the fate of his F.B.8 was sealed. So Farnborough's long-shelved design for a twin-engined ground attack fighter, F.E.4, was re-examined as a fighter-bomber, resulting in the issue of a new specification to Barnwell and de Havilland, and the Royal Aircraft Factory was instructed to complete the F.E.4 with all speed. The new twelve-cylinder air-cooled 150 hp RAF 4a or 5 was proposed for the twin powerplants, and a $1\frac{1}{2}$-pounder C.O.W. quick-firing gun was required in the nose, or alternatively two Lewis machine-guns, with a third Lewis mounted behind the wings. Frank Barnwell proceeded with a large, conventional, equal-span biplane having the engines each side in mid-gap similar to Pierson's twin-engined design for Vickers. As a result of his own flying experience Barnwell considered that twin Lewis guns in the nose cockpit had combat advantages, but less logically located the pilot behind the wings, where he hopefully had to manipulate an aft-firing Lewis gun. No dual control was provided, nor even speaking tube intercom. In fact Barnwell was groping his way, and the exercise resulted in heavy structural weight for a machine of 53 ft 6 in span, compared with the much bigger F.E.4 which weighed 70 lb less, despite 75 ft for the upper and 62 ft 6 in for the lower wing, and carried 1,000 lb greater load. The Farnborough design supervised by S. W. Hiscocks, who had draughted de Havilland's B.S.1, scored through better research and mathematical background, and was more original and advanced, a particularly noteworthy feature being the underslung fuselage with the lower wings attached to its top longerons. The nose featured a long cockpit with a gunner seated behind the pilot, and a second gunner located behind the wings. The engines were installed as pushers on cantilevered bearers sprung from the base of the single interplane struts at that point, thus considerably reducing resistance compared with Barnwell's arrangement, yet were so far behind the leading edge that an unnecessarily aft C.G. resulted.

However, de Havilland adopted the same arrangement, influenced by his Farnborough days in knowing the F.E.4 design concept. He and Charles Walker schemed an even more outstanding machine, with similar low-slung fuselage to the Farnborough design, but with equal-span wings like Barnwell's Bristol T.T. Holt Thomas proposed building it as a private venture. Both the F.E.4 and the new D.H.3 had three-bay wings which

could be folded outboard of the engines. It was now that the value of Walker's sound structural design was revealed, following his experience of redesigning stouter wings, struts, and bracing for the production D.H.1A. The long fuselage of the D.H.3 showed great advance on de Havilland's design work at the Royal Aircraft Factory, and from nose to a foot abaft the trailing edge was covered, like Martinsyde designs, with a stressed skin of plywood. The slender rear fuselage of normal wire-braced girder construction terminated in a generous fin and rudder of outstandingly attractive profile derived from the curved shape de H. used for the B.E. series. More practical than other designers, de Havilland placed the pilot in line with the leading edge of the lower wing and the gunner in the nose, adding like the F.E.4 a second gunner well behind the pusher propeller tips. The entire design was far ahead of any German.

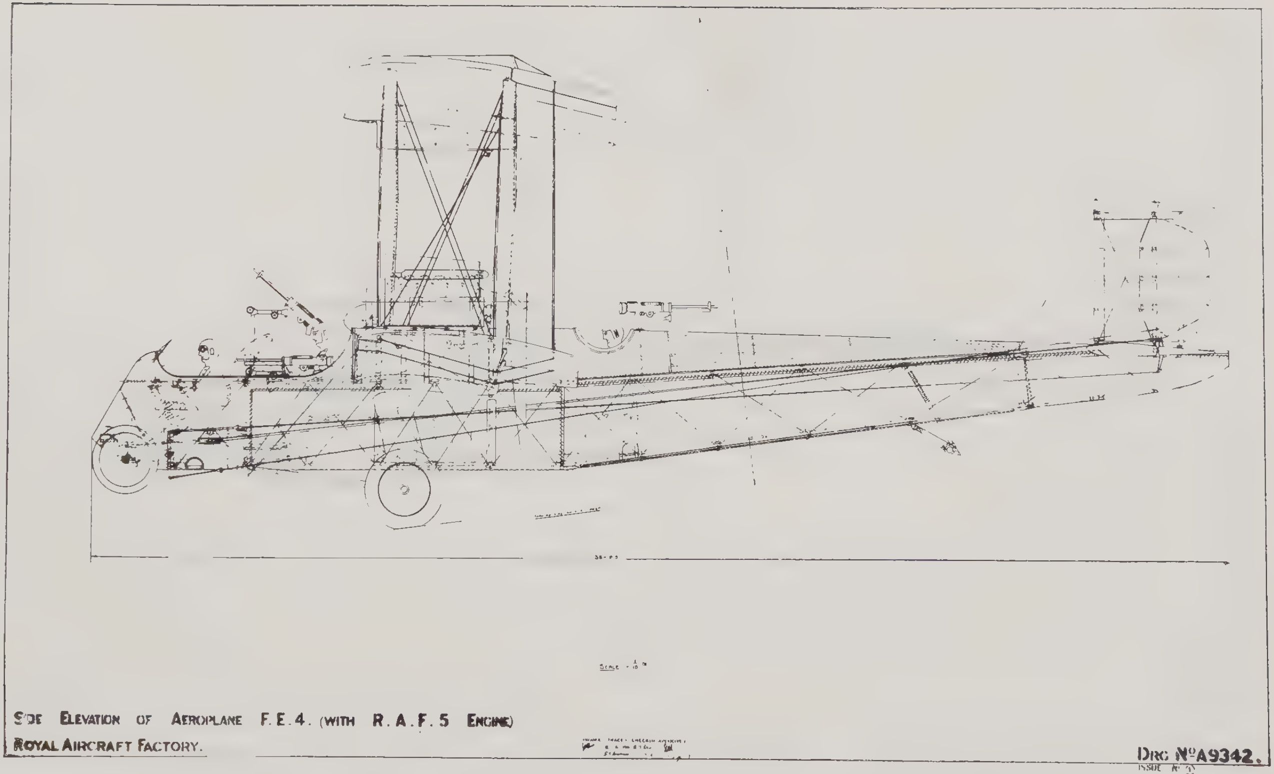
Most spectacular of all new aircraft was the giant Handley Page O/100, ready at last for flight. Construction had presented many problems, and specimens of every item – such as spars, struts, undercarriage construction, main fittings – had been tested to destruction in seeking absolute assurance that adequate safety factors had been achieved. From H.P. himself to the office boy, every workman and technician had worked on this imposing machine seven days a week, latterly modifying it to take the new Rolls-Royce engine, known as the Eagle, which luckily was now available in early form, rated at 250 hp at 1,600 rpm.

Handley Page's later colleague and collaborator, Dr G. V. Lachmann, recorded that: 'All through 1915 the Handley Page designers and workmen slaved in the old Riding School at Cricklewood Lane. Their number rose to 150, and additional buildings, including the Rolls-Royce repair depot next door, were rented. Even the Skating Rink in Cricklewood Broadway was used, and the Maternity Home was taken over as a drawing office. Gone was the old 52-hour working week. Beginning at 7 a.m. they laboured for 9½ hours each day, including Sundays.

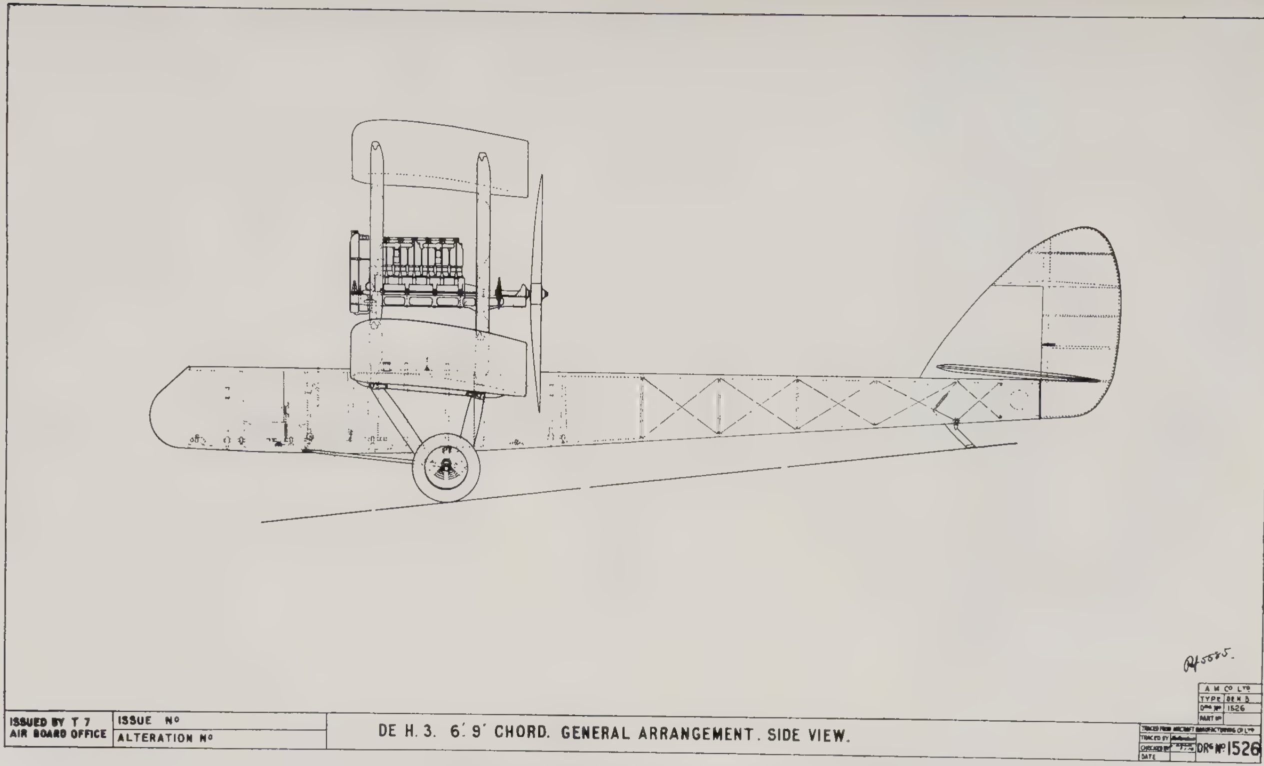
'At Cricklewood Lane only the manufacture of components could be undertaken. Sub-assemblies were transported along the Edgware Road to a building of 40,000 sq ft area in Colindale. Here a wind-tunnel, one of the first privately owned in the country, was set up and the work of providing aerodynamic data for the design was directed by R. O. Boswell of the Northampton Institute.

'On the night of the 9th December 1915, this great machine, with wings folded to the fuselage, was slowly pulled by a contingent of bluejackets towards Hendon aerodrome. Small trees barred progress at one point, so, calling for steps and saw, H.P. shinned up and lopped their branches to the alarm of figures in night attire appearing at neighbouring windows. It was a slow, bizarre procession; but after several other difficulties, such as marginal turns and burst tyres, Hendon was safely reached.'

With Lieut-Cdr John Babington, RN, at the wheel, accompanied by Lieut-Cdr E. W. Steadman, the first flight was a short straight one on 17 December. After adjustments, another was made, but when the machine



Original drawing of the F.E.4, largely designed by S. J. Waters and Henry Folland prior to de Havilland's design of the D.H.3. (*Royal Aircraft Establishment.*)



Print of original Airco drawing of the D.H.3. The back-set landing wheels were compensated by nosewheels for normal ground position, but the G.G. was so far back that the machine rested tail down. The front fuselage was ply covered, and the rear ply top had triangular lightening holes.

Unique photograph of the prototype Handley Page O/100 showing the original short nose with large cabin windows. The engine nacelles were armoured and contained the fuel tanks. In this form the elevators had balances. As originally drawn, the leading-edge tip-curve swept unbroken into the aileron tips. (*H. Busteed.*)

was fully airborne at 45 knots, the pilot was in considerable doubt whether it would accelerate further, and the machine ponderously taxied back. Fully in command, Handley Page decided to change the huge, armoured, honeycomb radiators which filled nearly all the space between top wing and each nacelle. The next few weeks went in fitting vertical tube radiators and testing the system with intention of making further test flights in the New Year. Critics prophesied disaster, but Frederick Handley Page remained imperturbably confident that trials would vindicate his great machine as a complete success.

7

The Derby Scheme did not appear to be working satisfactorily: there was bitter criticism of discrimination by local committees who decided whether a man's work was a reserved occupation or not. The atmosphere was rapidly leading towards conscription. Meanwhile the Germans were easily maintaining the fighting fronts on both sides of their country.

Public criticism of administration continued to mount. There were our men in the trenches, making do with typically British improvised hand grenades and trench mortars and sniping posts, while at home the War executives were reputedly leading a life of social ease. That something really was wrong seemed confirmed at the beginning of December when General Sir John French handed over command in France to Sir Douglas Haig.

Strangely enough, news of the Dardanelles evacuation printed in the newspapers just before Christmas brought sense of relief rather than disaster, for withdrawal had been successfully made during the nights of the 18th and 19th without loss of a single life. As details gradually became clear the operation began to take the aspect of yet another British epic, rendered typically ingenious with clockwork and time-fuse devices which fired rifles and hurled bombs to give the impression that the trenches were fully occupied when in fact they were empty. Only the towering flames of

abandoned stores, burned at the last moment, made the Turks realize that they had been outwitted. Many a home-loving Britisher believed it Divine intervention that there had been no slaughter to match that of the original landing when so many were bereft of their sons.

By now the British Army was counted in millions. That Christmas parcels were sent to the troops on great scale, with gifts of cigarettes, scarves, mittens, socks, and even plum pudding – for practically every house in the country felt it must take some soldier under its care. To do so seemed a moral relief that justified the stay-at-homes – whether able-bodied or too old or ill to join in active warfare – but they were banned from giving drinks to soldiers by the 'No Treating Order' issued under the ubiquitous DORA or Defence of the Realm Act, though actually directed against excessive drinking among the now well-paid factory workers.

Before 1915 was out Lloyd George made a stirring speech in the Commons aimed at galvanizing the electorate into understanding the overwhelming necessity of more and yet more munitions. But those working at machine tools intent on their 60-hour week were sceptical. They saw shell-cases, noses, and small arms stacked by thousand upon thousand, pouring into Army dumps in unending stream, and were convinced they were being exploited into over-production, so that management could secure huge profits.

Of this attitude the fiery, clever, loquacious Lloyd George declaimed: 'Nothing could be more malevolent, nothing more mischievous. You can talk of over-ordering when we have as much ammunition as the enemy. We have never yet approached the German or French production. The most fatuous way of economizing is to produce inadequate supply. £200,000,000 will produce an enormous quantity. It is 40 days cost of the war. If you have it at the crucial moment, your war might be won within your 40 days: if not, it might run to 400 days. What sort of economy is that?'

Enlarging on the problem of Supply, the Munitions Minister continued: 'The right part of economy is not to reduce output, but reduce cost. Labour alone can help here. Only eight per cent of the lathes in this country are working night-shift. We have appealed to employers. They say: "We have not got the labour", and it is true. We have done everything to supply skilled labour; but we have nothing like the requirement. Unless organized labour allows us to place unskilled men and women at work hitherto the monopoly of skilled men we cannot do what we want. The weakness is this. Our bargain was that we should restrict the profits of the employer, and the fact that we have kept our bargain has been against us. A few employers have done their best with what is called "diluting labour", but they have met with unquestionable resistance and do not feel like embarking on a conflict with their own men in order to increase output which so far as their own profit is concerned makes no difference.

'There is only one appeal: it is to patriotism. The employer must face up to the local trade unions, and unless he puts unskilled men and women to the lathes we cannot enforce the Act of Parliament. Victory depends on it.

It is a question of whether you bring this war victoriously to an end in the year, or whether it lingers on in blood-stained combat for years. Labour alone has the answer.

'In this war the footsteps of the Allied Forces have been dogged by the mocking spectre of "too late". Yet the chances of victory are still with us. Though the elements for success in a short war were with our enemies, all the advantages that make for victory in a long war were ours, and still are, despite the enemy's better preparation, interior lines, unity of command, and greater readiness to learn the lessons of war and adapt himself to them.

'Now is the moment for putting the whole of our home energies into preparing for the blow to be struck abroad. Our fleet, and the gallantry of the allied troops, have given time to muster reserves. Let us utilize that time without a moment's loss. Let us cast aside the fond illusion that victory can be won by elaborate pretence that you are winning. Let us fling aside rivalries, trade jealousies, professional and political differences – everything. Let us be one people: one in aim, in action, in resolution, and so win the most sacred cause ever entrusted to a great nation.'

The Welsh Wizard, as they called him, not only was a great orator, but was neatly picking up the reins of leadership. He knew that not only incitement to greater man-power output was needed, but that the entire organization of material supply and an increasingly detailed system of intensive fabrication had to be extended with all possible speed. That it was evolving on the right lines in the aircraft industry was indicated by comment of C. G. Grey: 'The Aircraft Manufacturing Co has tackled the problem of large output by adopting the French *système global* which consists in having a vast quantity of minor parts made by smaller firms, under rigid inspection by the staff of the head firm, and assembling these items at the head firm's own Works. In this way all finished products are under direct supervision of the main management, and the sub-contracting firms are responsible, at their own expense, for the quality of component parts.'

Indeed, the Government was lucky to have an aircraft industry at all, for in the few years preceding the War it had not even provided subsistence level to the present major constructors who then were small private enterprise factories – if a few sheds could achieve that status. All they were given was a scattered handful of orders for half a dozen B.E.s a time, or an occasional specimen of a manufacturer's own design might be bought. Only the driving sense of vocation of the British pioneer-constructors had enabled them to provide a bulwark on which the Military and Naval chiefs were now dependent in building up the essential air power for war. Even in the twelve months before war started the Trade's total production was rating at no more than 100 aeroplanes a year – yet during 1915 the major manufacturers, in conjunction with sub-contractors, managed to achieve 1,414 two-seaters, 224 single-seaters, and 252 seaplanes including two flying-boats. Additionally 34 experimental types were constructed in expectation that one or two might prove successful enough to warrant production next year.

Supplementing the miscellany of Farmans, B.E.s, Avros and later D.H.6s, were many imported American Curtiss JN-4s known as the Jenny. (*H. Busteed.*)

Although this total of 1,924 aircraft – of which 710 B.E.s constituted the greatest number of any one type – represented twenty times the peace-time best, it was far from being the current fighting strength because it embraced many training aircraft as well as building up reserves against fighting and training losses. Therefore to augment supplies, 470 French aeroplanes were obtained, supplemented by an order for 210 Curtiss trainers and 54 flying-boats from the USA.

The crunch was inadequacy of engine supply. Had more been available of suitable type, undoubtedly airframe production could have been stepped up to suit. Once again recourse had to be made to the French. If they had not readily come to British assistance, despite their own imperative requirements, the picture would have been abysmal – for they supplied one engine against every two of the 1,720 British produced engines. Of the latter the greatest production, and still mounting, was for the already outmoded 90 hp RAF air-cooled vee fitted to B.E.s; yet compact, light rotary engines were needed most, for they were essential for the new fighters now being built, as well as for others in advanced design. Despite Holt Thomas's foresight in establishing British facilities for rotary engine production, they totalled only 350 for the year compared with 667 imported from the French.

Nevertheless the mounting numerical trend, whether for airframes or engines, indicated that currently envisaged targets should be met next year. But what had not been comprehended was that aeroplane techniques developed so swiftly that every new type was nominally obsolete within a few months of first flight – yet so great was the momentum of production that long runs of outmoded engines were inevitable.

Significantly, at the end of the year General Henderson relinquished his command in France to take charge of the Department of Military Aeronautics, and Trenchard, promoted to Major-General, became General Officer Commanding the RFC in the Field.

CHAPTER III

INDUSTRY GETS TO GRIPS
1916

'The New Year's light of 1916 arising upon a frantic and miserable world revealed in its full extent the immense battlefield to which Europe was reduced and on which the noblest nations of Christendom mingled in murderous confusion. It was now certain that the struggle would be prolonged to annihilating conclusion. The enormous forces on either side were so well matched that the injuries they must suffer and inflict in their strides were immeasurable.'

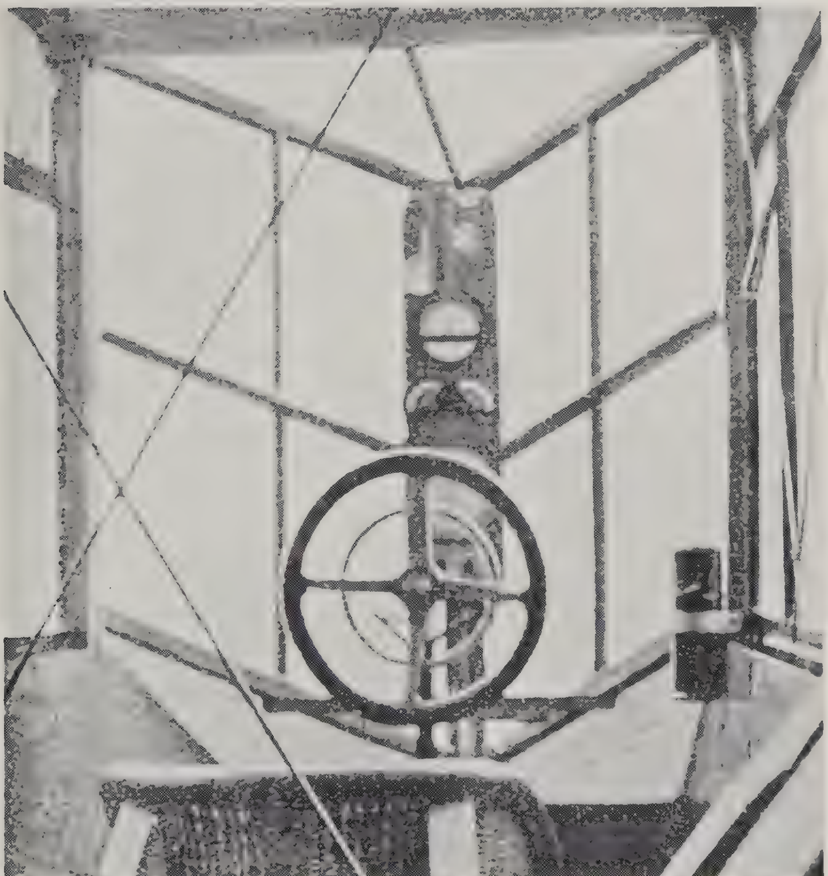
Winston Churchill (1925)

1

CHRISTMAS HAD provided no interlude for the Handley Page team. By working day and night the original high-drag honeycomb radiators of the O/100 were changed to vertical tube units mounted conventionally in front of each engine and partially ducted beneath it. The next straight, and subsequent flights, showed improved performance, but it was evident that the rudders were over-balanced, whereas to apply aileron to any considerable extent was almost beyond the pilot's strength. There were also anomalous shakes in the fuselage, and suspicion that the elevators, balanced by horns projecting beyond the tailplane, were not right. Although ground tests showed that the lateral control system suffered heavy friction due to the large number of pulleys, and was not improved by the high gear ratio, Handley Page was concerned that the real cause of difficulty might be aerodynamic, for he had himself meticulously checked the wind-tunnel tests on control hinge moments, but realized he might now be discovering the unexpected scale difference between model and full-size effect. There was no time for big changes. As a palliative, 3-in strips were added to the trailing edge of each rudder to make the balance ratio less, but until further flight experience had been gained, it was decided to leave the elevators and ailerons as they were. Even Farnborough had not fully appreciated that predictions from any particular wind-tunnel invariably showed consistent types of error, leading to possible over-estimation of rudder forces, for instance, but which could be empirically allowed for by the designer.

Reports of difficulty with this expensive and huge machine, added to

those encumbering the White-built A.D.1000, produced an outburst from the forceful Murray Sueter, who ordered Sqn Cdr Arthur Longmore, RN, to take over the machine at Hendon and fly it to Eastchurch, where the C.O., Commander J. L. Forbes, would supervise investigation by his team of naval pilots. Weather was difficult for a few days, but 10 January dawned clear, with only light breezes. The morning sunlight glinted on the sharply vee'd Triplex windows of the pilot's cabin as the Handley Page team pushed the machine from its hangar and spread the great translucent wings. Longmore scrambled up the hatch in the underside of the fuselage and, ducking through the transverse cross-bracing wires, made himself comfortable on the solitary wicker-work seat in the 'conservatory' forming the stubby nose.



The Handley Page O/100 had an acute-angled windscreen and deep cabin windows. The seat was of wicker-work, and the instruments were few as navigation was largely visual. The bubble statoscope mounted on the right was to check on level runs.


George Volkert (left) who played such an important part in the development of Handley Page bombers and Commodore Murray Sueter who was the greater founder of British naval aviation. He was largely responsible for the O/100 being built. (*Right hand Photo: Central Press.*)

To start the engines was an art. Rolls had not provided hand-turning gear. As the propeller tips were only just within reach, it was necessary to drag a double-sloped platform alongside so that man after man could run up, tug at a propeller blade, then run down the other side – the engine meanwhile being primed by hand pump. After what was judged a sufficient number of engine turns, the foreman ordered 'stand clear' and the pilot gave 'contact', then worked the hand-starting magneto. Success depended upon the smartness with which the men performed, but with a little drill the method became quite effective.

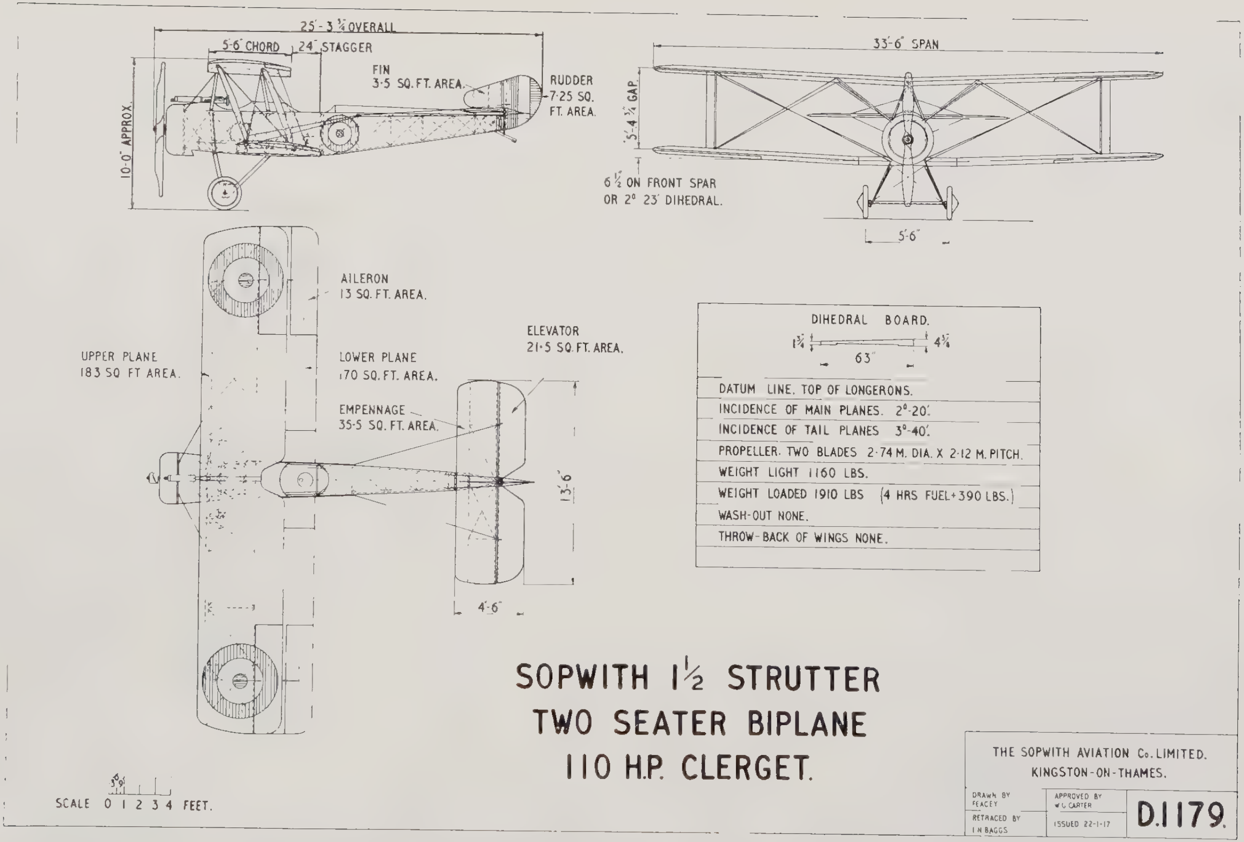
Once the engines started and warmed up, the flight to Eastchurch had little incident except loss of oil pressure and a drop in rpm of the port engine. Longmore hopefully assumed that the lightly laden machine would continue to fly on one engine if the other failed – but that would be exploring the unknown.

When trials began in earnest, the first attempt at speed runs resulted in such violent oscillation of the tail structure that it was visible from the ground. With expectation that catastrophe was imminent, Longmore snatched back the throttles – and was gratified to find the shaking dwindle and finally cease. After he landed, the fuselage longerons were found twisted and the bracing cables slack. Closer inspection revealed many struts bowed, and nearly all had bedded into the longerons owing to the small area of the ends, sometimes resulting in splitting the longeron itself. Handley Page and George Volkert rushed to Eastchurch by car. It was clear that the longerons twisted because of the offset pull of the bracing wires. Schemes were devised for splicing in new sections where split, fitting extra wires to give even pull on the fittings, and stiffening the struts at mid-point with kingposts. As a result the mathematical technicians of the Air Department at the Admiralty assured Commodore Murray Sueter that all should be well.

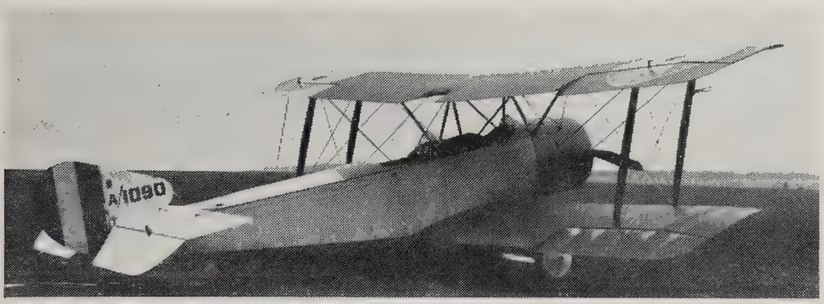
Within a few days a fresh attempt was made at speed trials. To everyone's dismay there was no difference: at 70 knots the tail started to oscillate violently – yet when the stiffened fuselage was afterwards inspected, no obvious defect could be found. The urbane Mr Handley Page, though secretly concerned, assured everyone there was no need to worry. He would give the next machine a redesigned fuselage which would certainly be satisfactory. The cabin enclosure would also be removed as the naval pilots disliked it because of misting and reflections which acted like blinds, though what they really felt was claustrophobia because they were conditioned to open cockpits.

No sooner had H.P. and Volkert returned to Cricklewood than further flight revealed the fuselage tipping up and down in the wings. Inspection found slack centre-section wires, which although taut before starting, had slackened through taxiing over rough ground, with the result that on applying elevator in the air, the fuselage moved to take up the slack. To stiffen the structure this cable bracing was replaced by swaged lenticular Rafwires. Thereafter many flights were made on this machine, but with speed restricted to 70 knots engine on, and up to 75 knots engine off – otherwise increasing tail vibration occurred. Meanwhile the Handley Page factory was once more working day and night completing the second prototype, No. 1456. To accommodate the new open cockpit the original nose had been cut off at the front wing spar and long, downward-sloping top longerons substituted, matched by similarly upward-extended lower members, terminating in a rounded plywood nose, which for the moment was sealed but ultimately would carry one of the new Scarff gun rings instead of the originally proposed spindle-mounted machine-gun abaft the pilot, firing forward over his head.

The Handley Page O/100 after the cabin had been removed and the nose faired over to the pilot's cockpit. The elevator balance, surround, and fabric had been removed leaving the ribs *in situ*. The tailplane incidence could only be altered by ground adjustment. (*Fleet Air Arm Museum.*)



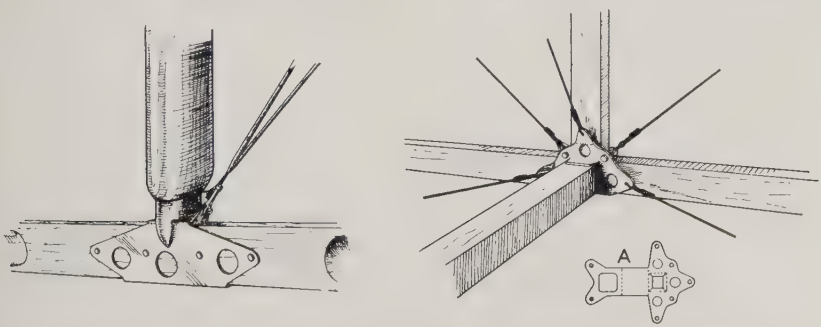
This general arrangement drawing of the Sopwith 1½ Strutter bears the approval of W. G. Carter who was then running the Sopwith production drawing office.



Like this dual-control Vickers-built 1½-Strutter, the Sopwith prototype had clear-doped fabric on tail and fuselage, but the wings were khaki and the nose was black. The instructor had full instrumentation in the rear cockpit. (*Fleet Air Arm Museum.*)

If Frederick Handley Page had his worries, Tom Sopwith and his team were riding the wave of success. His new two-seat fighter had been completed early in December 1915, and flown at Brooklands by Harry Hawker, who had no doubt about its fulfilment of intended rôle and splendid handling characteristics. Test flights by naval pilots of the prototype were proving an all-out success. They were unanimous that this new Sopwith conception and its detailed design looked right and was right, with firm, powerful controls – though the ailerons were somewhat heavy, so that the subtle integration of manoeuvrability and stability which makes or mars an aeroplane did not quite attain the perfection of the Avro 504. Almost immediately following the first flight, the Admiralty ordered 150 for urgent delivery to the RNAS, but the Air Department of the War Office appeared indifferent.

Initially called *The Bullet*, but officially Type 9700, it soon was referred to as the '1½-Strutter' by some wag who implied that additional struts had been added to the base of the centre-section trestle structure, rendering the outer arms of a W in front view. With varnished struts and creamy fabric gleaming, the new prototype appeared attractive and purposeful, and its clean single-bay wings of good aspect ratio promised high efficiency. Every detail was simple and practical, with the lightest possible structure



Typical Sopwith construction showing interplane strut socket and spar fitting (left) and fuselage spacer strut attachment (right) of ingeniously folded steel (A). (*H. Busteed.*)

of wire-braced, spindled wooden members and conventional fabric-covered flying surfaces and fuselage. To cut down the float expected with this clean design it was fitted with patented rotatable square flaps at the lower wing roots which could be turned up at right angles to act as air-brakes. An important new feature for which Tom Sopwith was later granted Patent No. 126,031, was a hinged tailplane with rear spar attached to an adjustable vertical jack operated by wires from a cockpit handwheel so that incidence could be adjusted to compensate for variation in C.G. Here was a device on which other designers quickly seized.

Item by item had been meticulously considered for simplicity of mass production coupled with maximum strength at minimum weight. Everything had logical simplicity. Thus longeron spacer-strut joints were 'nibbled' from light-gauge mild steel sheet following the contour of a template, and subsequently simple folding formed the sockets and lugs, held in place, without piercing the longerons, by two bolts which also anchored light shackles for the piano-wire bracing.

Smaller in span by 2½ ft than the famous and long-established Avro 504, the 1½-Strutter had 16 sq ft greater area, contributed by a 5 ft 6 in wing chord instead of the Avro's 4 ft 9¾ in, but stagger was identical although the wing gap was 7¼ in less. Dividends accrued from rigorous weight control, for the weight empty with a 110 hp Clerget was only 160 lb more than the 80 hp Avro 504, and the additional 30 hp and lower drag secured some 25 mph greater speed, with climb twice as fast. What gave this good performance overwhelming importance was the aggressive gun-power made possible by the interchange of cockpits for pilot and observer.

In *Wind in the Wires*,* 2nd Lieut Grinnell-Milne, an 18-year-old pilot, commenting on the difficulty of using the reverse arrangement standardized in the B.E.2c, wrote: 'The observer, sitting in the front seat, was enclosed by a cage of struts and wires which made it extremely hard to handle the gun and obtain a clear field of fire. . . . The forward gun-mounting gave an arc on either bow, above and below, but to fire straight ahead would send shots smashing a propeller blade and bring the machine down. To hit our enemy we had to turn slightly away, put in a burst or two, and turn back quickly to avoid opening the range.' It was a most inefficient way of fighting, though on more than one occasion an observer deliberately shot through the propeller disc, chancing that his 400 bullets a minute would miss the whirling blades or only damage them slightly. 'The only thing for which we could hope,' continued Grinnell-Milne, 'was that someone would speedily invent safer means; but with characteristic British skill at compromise, our designers produced an extraordinary craft which in their fertile brains did away with the problem altogether. It was called the B.E.9, though the reason for its unofficial name – The Pulpit – was all too obvious. A little 3-ply box projected from the front, supported upon ball-bearings running on an extension of the propeller shaft. The wretched man in this box had indeed an unrestricted forward view, but just behind

*Published by Hurst & Blackett in 1938 and re-issued (1957) by Panther Books.

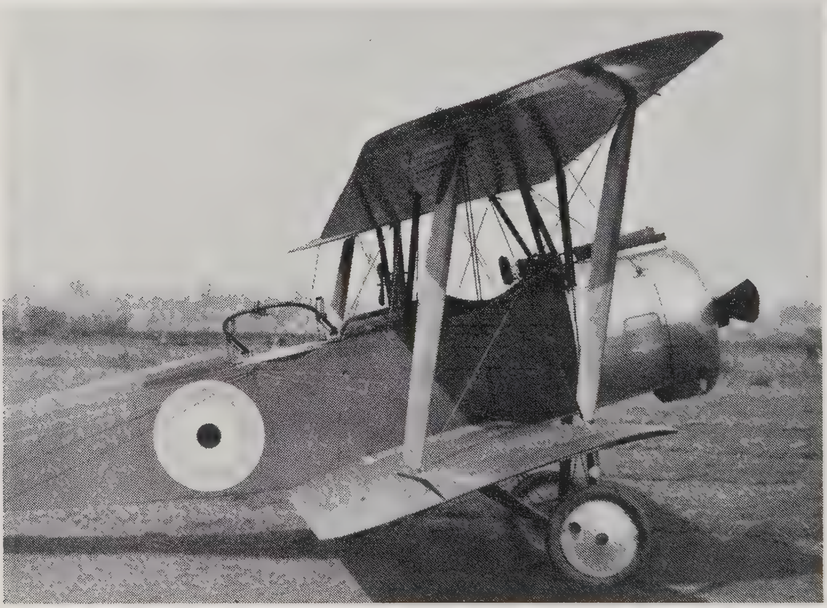
his head revolved the four deadly propeller blades. . . . One of these machines was attached to the Squadron, but never succeeded in defeating an enemy craft, and although almost every new machine was looked at with delight and wonder, it was recognized that in the B.E.9 unsuitability of design had reached its acme. The Pulpit was quickly returned to the depot.'

The B.E.9, with gunner's nacelle in front of the propeller, awaiting test on the heathy aerodrome of Farnborough. As early as 27 February, 1915, the SPAD company in France had been granted a British patent for a similar arrangement and its variants. (*Imperial War Museum.*)

The new mode revealed by the 1½-Strutter's Scarff-Dibovski synchronizing gear for its forward-firing Vickers gun is of historic importance. A simple socket and pillar mounting was temporarily used for the rear gun, though the cockpit was made wide enough to take Scarff's forthcoming circular, rotatable gun ring, derived from a cumbersome Nieuport ring-mounting in turn based on wooden gun rings originated by the German Air Force. Scarff's ring was metal and its important feature was a spring-compensated U-shaped gun-arm hinged to it at mid-diameter to give free elevation. The Sopwith would thus have a fully defensive field of fire in a hemisphere from above the centre-section to beyond the tail and back to the trailing edge of the lower wing, as well as lethal fire forward.

Equally eye-catching in the Sopwith experimental department stood the little single-seater which under the impetus of Harry Hawker's eager care would soon be ready for flight. Though subject to bouts of illness, Harry rarely showed it. His was a ready smile, even if his remarks had occasional sting, for he was difficult to satisfy when he wanted a special part made, sometimes grabbing it and completing the job himself. He would go up to Len Pollard and preface his explanation with: 'Now don't think about what you're going to say to *me*, but listen to what I am going to say to *you*!' A few found him too opinionated; others realized that every word

was sound common sense. Tom Sopwith would keenly interrogate him, seeking the fundamentals of proposals his pilot put forward, but recognized him as a genius. The final proof lay in the flying qualities of Sopwith machines. In the new fighter Hawker was certain they had a winner, for the S1.T.B.P. prototype had already foretold the quality of this developed and rationalized design.



The Sopwith 1½-Strutter with fixed gun firing through the propeller disc, and a Scarff universal rear gun mounting.

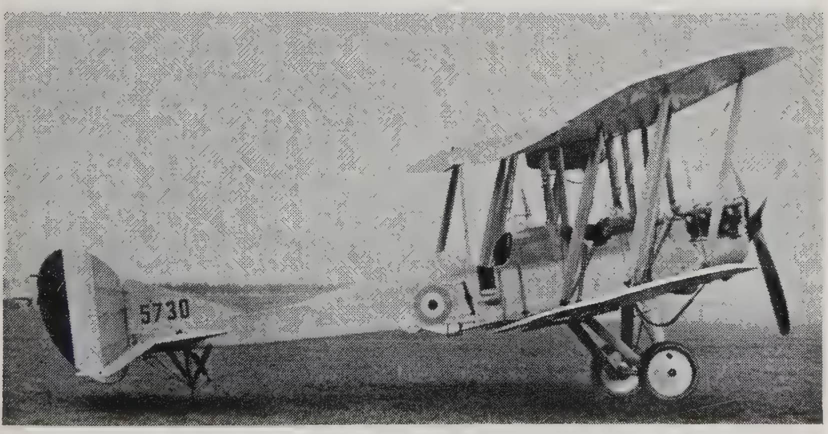
Success had already come to the pursuasive Dutchman, Frederick Koolhoven. His F.K.3 proved an instant success and, for no very clear reason to the RFC, was even easier to fly than the B.E.2c from which it was largely copied. But there were slight though important aerodynamic differences, for wing incidence was almost half the B.E.'s, and despite greater wing surface the tailplane was smaller to reduce longitudinal stability compared with its excessively stable precursor. By using a horn-balanced rudder Koolhoven reduced out-of-trim forces which with the B.E. required constant foot load anu became tiring. Tyro-pilots were certainly pleased to find that if they made a heavy landing nothing disastrous occurred, for it was cushioned by excellent oleo shock absorbers within the fuselage, whereas other Service aircraft universally used rubber shock cord which had marked rebound. The wheels were further forward than the B.E.'s, and the stout, Avro-like central skid prevented nosing over in a fast tail-high landing. Koolhoven's pioneer piloting had stood him in good stead in diagnosing what would please the RFC.

The prototype had completed flight tests when he saw the new Sopwith

With a few relatively simple changes Koolhoven and Noorduyn managed to alter the entire appearance of the B.E.2c into an up-dated and more effective machine, the F.K.3, which was some 10 mph faster though the climb was no better. (*D. F. Woodford.*)

1½-Strutter, and realized that its disposition of cockpits indicated the shape of the future. Production of F.K.3s had not advanced too far for modification, so Koolhoven switched his cockpits, bringing the crew close together in a single long opening, and mounted a Lewis gun on a pillar at its aft end. He also fitted a deeper fin for greater directional stability, replacing the rudder's rounded horn balance with a triangle which continued the fin shape. As a last refinement cable wing-bracing was replaced by Rafwires for which both Messrs Brunton and Vickers Ltd were fully tooled for swaging.

A few months earlier Koolhoven had obtained a valued recruit, and the F.K.3 production version was the outcome. He was Bob Noorduyn, similarly of Dutch descent, apprenticed pre-war at Armstrong Whitworths, and recently designing with Sopwith, but who joined the AID early in 1916 as their No. 1 Inspector and was posted to the Armstrong Whitworth Aviation Department at Gosforth where he met Koolhoven and joined



Standard B.E.2d built by the British and Colonial Aeroplane Co. (*D. F. Woodford.*)

The production Armstrong Whitworth F.K.3 'Little Ack' with robust long-travel undercarriage. The type was used extensively in the Middle East. (*D. F. Woodford.*)

his small staff. As two Dutchmen, they got on together quite well, but Noorduyn had initiative of his own, and it seems it was he who draughted future designs.

The jubilant Koolhoven was now in a strong position to argue the War

In the quest for better performance the 90 hp RAF 1a of the F.K.3 was changed for a 105 hp RAF 1b and eventually a 120 hp Beardmore as seen here. (*D. F. Woodford.*)

Office into giving him opportunity for further *de novo* designs. Of five tenders for an entirely new and larger two-seater, the F.K.8 was selected as potential replacement for the F.K.3. The 'Big Ack W', as it was soon nicknamed, had unmistakable family likeness to the F.K.3, but gave even greater confidence to pilots because of its impression of rugged strength, though was somewhat clumsy looking. Yet it weighed only 300 lb more than the F.K.3, despite an estimated disposable load of 900 lb; but the prototype was limited to 750 lb because it was initially underpowered with an available 120 hp Beardmore in lieu of the 160 hp model for which it was designed. Like the Sopwith 1½-Strutter it had trestle-like inverted V centre-section struts, but they were greatly emphasized by an extraordinary inverted V radiator hanging in front, suspended from the centre-section and trailing down each side of the angular cowling. Below it was a very robust undercarriage scaled-up from the F.K.3, with steel tube replacing the wooden skid probably inspired by the equally strong undercarriage of the Factory's F.E.2a.

Tested in May by Lieut Peter Legh, RN, of the Naval detachment at Gosforth, the F.K.8 proved pleasant to fly and easy to land. With its fixed forward-firing synchronized Vickers gun and rear cockpit Lewis it was clearly going to be much more satisfactory for reconnaissance than the great fleet of B.E.2cs plodding up and down the Front line as they spotted for the Artillery. Understandably the new machine cost £300 more per airframe than the B.E., but Mr Turner and his men at the Air Board were instructed to accept this high price, and big orders were forthcoming. Koolhoven was established – though a great part of the credit was due to Noorduyn. Indeed, Koolhoven was regarded by some contemporaries with doubt when it came to questions of real engineering knowledge, but undoubtedly he had that vital gift of imagination and the presence to put over the case for a new project in the same successful manner as that other Dutchman, Fokker, who was working for Germany.

The Armstrong Whitworth F.K.8 'Big Ack' first flew in May 1916, with a 120 hp Beardmore, but subsequently the 160 hp Beardmore was used. (*Imperial War Museum.*)

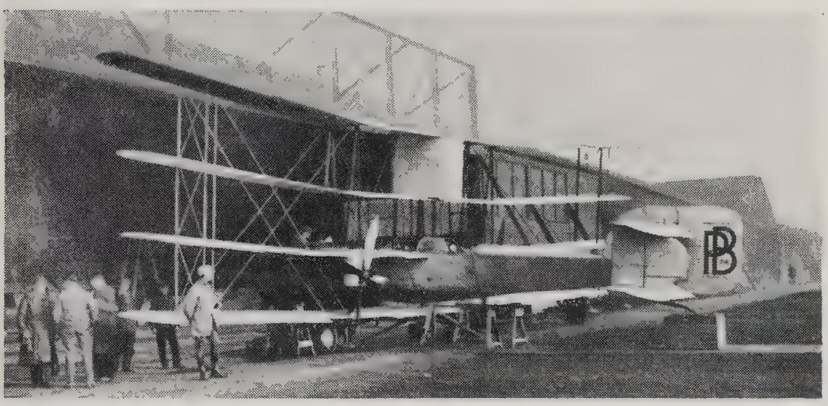
After long opposing national conscription, Sir John Simon, Secretary of State for Home Affairs, had resigned on 4 January at finding the Derby recruitment response showed no less than 650,000 unmarried men had evaded enrolment. Compulsory service was the only answer in a war costing £5,000,000 a day yet resulting in stalemate. Somehow we had to obtain sufficient preponderance of men and munitions to beat Germany's vast resources; so the next War Budget estimated expenditure at £1,590,000,000. Economize; reduce meals; avoid travel; invest in War Savings – these were the parrot cries of the official refrain – and Savings Certificates issued at 15s 6d sounded not only patriotic but an investment since it was promised they would be worth £1 in seven years time.

Yet it was not these exhortations, nor mounting casualty lists, but the threat of further Zeppelin raids which was bringing home to civilians the deathly reality of war for we had long given up sticking little flags on *Daily Mail* maps. There had been 19 raids by these great airships during 1915 – and the last, on 13 October, under a calm and starry sky, fully demonstrated that our island nation was no longer immune: 40 had been killed and many injured in this biggest raid yet mounted. Owing to lack of men and guns there had been practically no defence of London, though the RFC and RNAS did their best with Avros and B.E.s. Public concern led to Admiral Sir Percy Scott, a famous gunnery officer, taking over London gun defences from Commodore Murray Sueter, for whom it had been one of many responsibilities as Admiralty Director of Air Services. There had been contention in high places, Sueter arguing that existing aeroplanes were useless for night defence, though Scott, from professional knowledge of gunnery limitations, had predilection for aircraft. Thereupon Lord Kitchener instructed General Henderson that the Army must help, and a London Air Defence Observer Corps was initiated to screen the country from the coast to London with mobile guns, searchlights, and the magnificent total of six RFC pilots available at three night-landing grounds.

Handley Page's friend, tall, slick and monocled Noel Pemberton Billing, took opportunity of cashing in on public feeling. His tempestuous temperament had resulted in officially sponsored retirement from the RNAS where he had attained rank of Lieut-Commander. He now proposed standing for the Parliamentary vacancy in Mile End constituency caused by elevation to peerage of their Member, the Hon Harry Lawson. In a speech at Mile End Palladium on Sunday afternoon, 16 January, Billing resoundingly declared: 'In Parliament I shall be able to enforce such vigorous air policy that German aircraft will be attacked wherever they are built or harboured. They will be fought in the air before they reach our shores, and the sky over London will be so well guarded that if any escape they will never dare return. It can be achieved if our airmen are given a chance – but they have not because the Government has not realized the power and effect of the aeroplane in warfare, or the necessity of efficient

organization of the air service. The British airship which flew over London a few days ago would not be much good against a Zeppelin; but we have a machine – it flew for the first time this morning – which carries an armament before which a Zeppelin would turn back and never come here again.'

Mr Horatio Bottomley, his paid supporter, together with the trade unionist Ben Tillet, proclaimed that Mr Billing was too modest, for not only was he the inventor but the builder of that machine and the day he was returned to Parliament he would fly with it over Mile End and from the skies drop his vote of thanks to the electors.



Noel Pemberton Billing's quadruplane solution for an anti-Zeppelin night fighter – the P.B.29 – utilized a streamlined gunner's turret which was similarly adopted by the later Sage Type 2 fighter.

Named the Night Fighter P.B.29, this aeroplane was built by Pemberton Billing Ltd of Woolston in only seven weeks at their Supermarine Works under the zealous eye of Hubert Scott-Paine, known from the colour of his hair as 'red-hot' or 'flaming' Paine. Deeming a minimum flying speed of 35 mph essential in order to hover above London in a breeze, Billing sought sufficient area by using quadruplane configuration, offsetting the increased resistance by high aspect ratio and a single bay of struts beyond the pusher 90 hp Austro-Daimler underslung each side from the lowest wing but one. Separate dual-control cockpits were located in front and behind that wing so that two pilots could be carried as contingency against disablement, but the eye-catching feature was a streamlined nacelle, built around the centre-section struts between top and second wing, accommodating a gunner. Flying and landing wires were daringly taken direct from top wing to bottom. As precaution against rough landings at night a strong undercarriage with twin wheels and stumpy skids was fitted beneath each engine, braced with twin sloping struts to the centre-line of the lower wing.

The Admiralty was interested. Flown to Chingford for test by naval pilots, this unique aeroplane almost immediately crashed on an early handling flight. Nothing daunted, Pemberton Billing proceeded to

redesign, and this time Scott-Paine secured a development contract for it as an anti-airship patrol machine.

Despite the vigour of his non-stop Parliamentary campaign Pemberton Billing was defeated by Mr Warwick Brookes who, interviewed by the *Daily Telegraph*, said with a knock at Billing that there was one message he particularly desired to give to the electors: they must keep a calm and steadfast courage, uninfluenced by exaggerated statements on protection from air raids, and trust Sir Percy Scott as the greatest gunnery expert in the whole world.

But the perils of inadequate air defence continued to perturb the populace on whom the Army was utterly dependent for munitions, vehicles, clothing, and food. At the end of the month came raids on Norfolk, Suffolk, Lincolnshire, Leicestershire, Derbyshire, and Staffordshire, creating great fear. Said *The Times* in an endeavour to offer truer perspective: 'Home defence, however important it seems after a raid like that of last week, is only a part of the great problem of mastery of the air. There will be plenty of time to talk about reprisals as effective measures to stop air raids at their source when we are in position to wage war on the enemy instead of letting him wage war on us. We are not in this position; and the question is how most rapidly to increase our means of offence? We believe that a vital measure is to put control of aircraft production under a single head. At present there is no centralized policy. Everyone knows that the "generous rivalry" between the Services of which Mr Balfour spoke has not in practice amounted to anything but deplorable and expensive competition for machines and men, with wasteful lack of co-ordination in technical results. A machine designed by the Army authorities is apt to be condemned by the Navy – which likes to "do things its own way" – simply because it is an Army machine, and *vice versa*. But the air is common to both Services, although the conditions in which machines are employed by one or other may render necessary certain differences in constructive detail. If an Air Minister is appointed he will have to suppress with firm hand the internal struggles, whether between the Services themselves, between them and the technical experts, or between all of these and the financial authorities – for this has hitherto greatly retarded progress.'

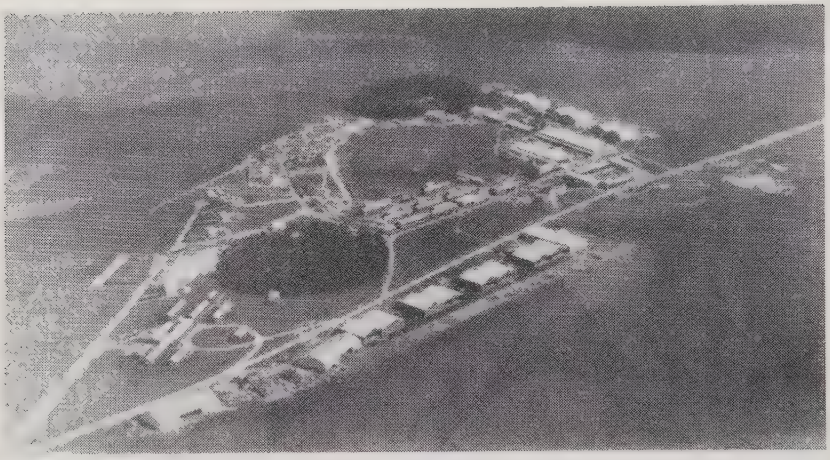
Like the Services, the many generalized companies diverted to aircraft construction were suffering the perils of inexperience. Except for the knowledgeable pioneer constructors – British and Colonial, A. V. Roe, Sopwith, Handley Page, Blackburn, and Vickers – grave mistakes were being made, such as use of unsuitable timber provided by newly appointed 'experts' in lieu of the highest grade spruce and ash essential to attain the necessary strength reserves on which stress calculations were based. Wooden airframes must have straight grained material, free of disease, to realize maximum strength and resilience, but ash was proving sappy, and spruce becoming difficult to obtain from the forests of USA. Not only were there serious losses due to torpedoing of timber-carrying ships, but

American aircraft constructors were stock-piling, realizing that their country must soon be involved in the fight and would require tremendous aircraft production itself. The saving feature in Great Britain was the wise care of the Aeronautical Inspection Department where Capt Bagnall-Wild was now Chief Inspector, and Capt R. H. Verney was Inspector of engines. Towards the end of 1915 decentralization into district organizations with their own test resources had been inaugurated. Since then staff had been tremendously increased, and the AID pioneered women as aircraft inspectors finding their keenness, energy and ability very suitable for this work: eventually 50 per cent of the staff were women.

Everywhere the AID were alert to see that proper processes were adopted, for many contractors had previously dealt somewhat lightheartedly with metal work, unaware of fatigue limitations, and were now required to adopt careful procedure in heat treatments, and use adequate lanoline or paint to prevent corrosion. Control was exercised at the very source of firms supplying materials and sub-contracted components, rather than wait for items to arrive at the main contractor, and led to a system of Release Notes identifying and vouching for inspected material. Even with main contractors the influx of new and unskilled labour made it essential for the AID to counter-check samples from the firm's own inspection department. The Department also assumed responsibility as technical advisers to the Military Aeronautical Directorate for essential airframe, engine, and equipment modifications. It was a complex which was continually expanding, yet flexible enough to cope with swiftly developing aircraft design where new horizons must be continually sought in size, load carrying, speed, and offensive power. Behind it all were the facilities and vast scientific knowledge of the Royal Aircraft Factory.

As further safeguard there was now a Testing Establishment which had developed from an Experimental Flight attached to the Central Flying School at Upavon. First commanded by Capt A. H. Soames, MC, he had as principal assistants Lieut G. M. Dobson, who originally joined as civilian meteorologist, and a young scientist, Lieut R. B. Bourdillon. Their terms of reference were to 'devise methods of mounting guns in aeroplanes, develop visual signalling from aircraft, bomb-dropping apparatus and sights'. Soon Capt Soames met his death during ground tests of the first 500 lb bomb, and command passed to Capt G. B. Stopford, RA, following temporary appointment of Lieut Clarke, RN.

More was needed than the Trade's assessment of its own aircraft. Their paid test pilots might well be perfectionists in judging a machine's flyability, but deficiencies were often revealed when Service pilots used these aeroplanes in war. This led a newcomer to flying, a young chemical scientist, Lieut Henry T. Tizard who was engaged on bomb gear development with Bourdillon, to realize that there was need for orderly check testing of aeroplane performance. Unaware of O'Gorman's earlier work on performance measurement, Tizard postulated the necessity of an unchangeable yardstick by which all aeroplanes could be compared and, with



Home of test flying was the Central Flying School at Upavon on a smooth curve of the Wiltshire downs. Under the command of Capt Godfrey Paine, RN, the CFS was officially opened on 19 June, 1912. In 1916 the Experimental Flight was housed in two of the hangars in the foreground.

the help of the well-known meteorologist W. H. Dines, determined a standard density to which all readings would be corrected. A mile-long speed course was marked on the Upavon Downs for timed runs into and against wind, and climbs to 6,000 ft were recorded by barograph, with note of temperature and time every 1,000 ft.

'There are some who lay considerable emphasis on every test instrument being self-recording,' wrote Tizard, 'but I place much more reliance on direct observation, as the results are there, and no time is lost through failure of a recording instrument to record; but whether recording or direct reading instruments are used, it is the flyer on whom accuracy of the test depends. I feel too great stress cannot be laid on this; he is the man who does the experiments, and like all experimenters in every branch of science, he requires training and a great deal of practice. Although methods themselves may become greatly changed, this much can perhaps be claimed – that the general principles on which they are founded are sound, and will only be altered in detail.'

3

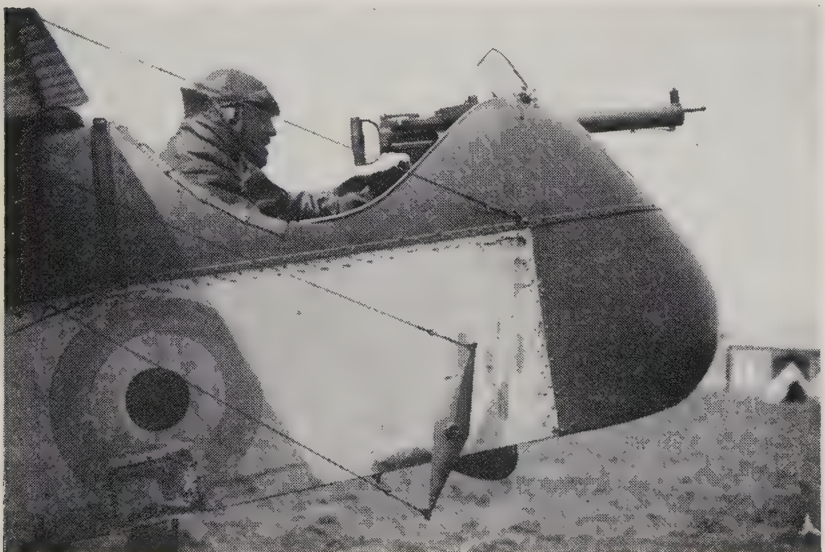
Reports of increasing German air superiority were filtering through. Significantly Philip Gibbs, War Correspondent of the *Daily Chronicle*, writing from British GHQ warned: 'The rapid succession of British aeroplanes brought down during recent weeks has caused anxiety lest we are losing supremacy in the air. A run of bad luck following the sudden appearance of the Fokkers has perhaps over-emphasized the menace of the enemy's new type. It is purely a fighting machine, built exclusively for chase, and neither stable enough nor able to carry sufficient petrol for reconnaissance work. It lies in wait for our scouts coming over its lines,

climbs quickly, and then makes a hawk-like swoop, escaping to its own lines if it meets serious opposition.

'Difference in policy between British and German air services accounts for the Fokker's successes, though leaving the advantage with us according to our Air Chiefs. For every German aeroplane over our lines, four British fly over theirs. As daily routine our airmen reconnoitre the enemy's positions, bringing back useful information. German policy is not so courageous; their artillery observation work is from mainly above their own lines. Thus our men have fewer chances of chase within the allied frontiers. Probably our policy will not be altered. Results of continual reconnaissance are too valuable to abandon, and the only question is to find methods of defence against the fighting Fokkers. It is revealing no secret – because the enemy has already discovered it to its cost – that we now have a machine matching the German type in speed and hunting ability, designed especially for air combats, and carrying a gun firing straight ahead.'

It was the new D.H.2 pusher, with which No. 24 Squadron, commanded by Major Lanoe Hawker, was being equipped. Twelve of these fighters arrived at St Omer on 7 February; two more squadrons in England would soon be ready to follow.

Unfortunately the D.H.2 was not proving popular. Few pilots had more than 50 hours flying, so the mere appearance of this compact machine gave the impression that it would be vicious compared with the leisurely Maurice Farmans on which they had learned, very amateurishly, to fly.



Big pilot in little aeroplane, showing fixed gun installation in a pusher – Capt Andrew Lang, later holder of the height record, and his D.H.2 in France. (*Imperial War Museum.*)

The gyroscopic effect of the spinning rotary engine tended to distract because left rudder had to be held on while making a right-hand turn, and in the confusion loss of speed could result. The relatively swift control response made the D.H.2 seem a super death-trap, and even more so when cautiously skidding turns were made too slow and the machine dropped into a spin. Quickly it became known as the 'spinning incinerator', though experienced pilots found it easy to recover by centralizing rudder. Certainly the trick of aiming the aeroplane with its gun fixed centrally, instead of orientatable from port and starboard alternative mountings as on the prototype, was proving ideal. On 23 May, General Sir Henry Rawlinson, GOC of the Fourth Army, reported that: 'The de Havilland machine has unquestionably proved superior to the Fokker in speed, manoeuvre, climbing, and general fighting efficiency,' but that was being over-optimistic.

Better things were on the way. At Brooklands Harry Hawker had taken the new Sopwith single-seat fighter for its first flight, and found it delightful. It was the prettiest little aeroplane so far built. Hearing from his Admiralty colleagues of the successful test, Colonel Brancker drove down from the War Office to inspect the machine – for here at last was the vital answer: a single-seat tractor really capable of competing on decisive terms with the Fokker. Fitted with the first of the Sopwith-Kauper mechanical synchronizing gears, its single Vickers gun mounted centrally on the turtle deck just ahead of the pilot would spray hell to the Germans.

Arriving at the famous race-track Brancker found this latest Sopwith alongside the bigger 1½-Strutter. That they had come from the same stable was obvious. 'Good God!' said Brancker. 'Your 1½-Strutter has had a pup.' And Pup it was ever after, capturing the affection of all who flew it with flying qualities of such exceptional standard that fighter pilots, such as Major Oliver Stewart, in *The Clouds Remember*,* recollected it as: 'The perfect flying machine . . . one which gave a high return in speed and climb for a given expenditure of horse-power; which had well harmonized, powerful controls; which was stable enough but not too stable; which was sensitive enough without being too sensitive, and obeyed the pilot in a way which secured his lasting admiration and affection – the Sopwith Pup was, and still is, without superior.'

However, Major Moore at Eastchurch cautioned that: 'The Pup could be blamed a little for various accidents on other machines because it had such a large speed range and was so controllable and nice that, when a pilot went from it to another, he tended to forget that flying on the whole is not so easy as the Pup would have one believe.'† More critically, one of the young RNAS pilots on active Service wrote: 'Our 90 hp 17 sq metre Nieuports have been replaced by Pups which are a little faster and fly higher, but hopeless for diving because they build up so much speed so quickly that you can feel in the seat of your pants that the wings will soon tear off. At 120 mph our hearts and breath seem to cease and not start

* *The Clouds Remember* by Leonard Bridgman (Gale & Polden).

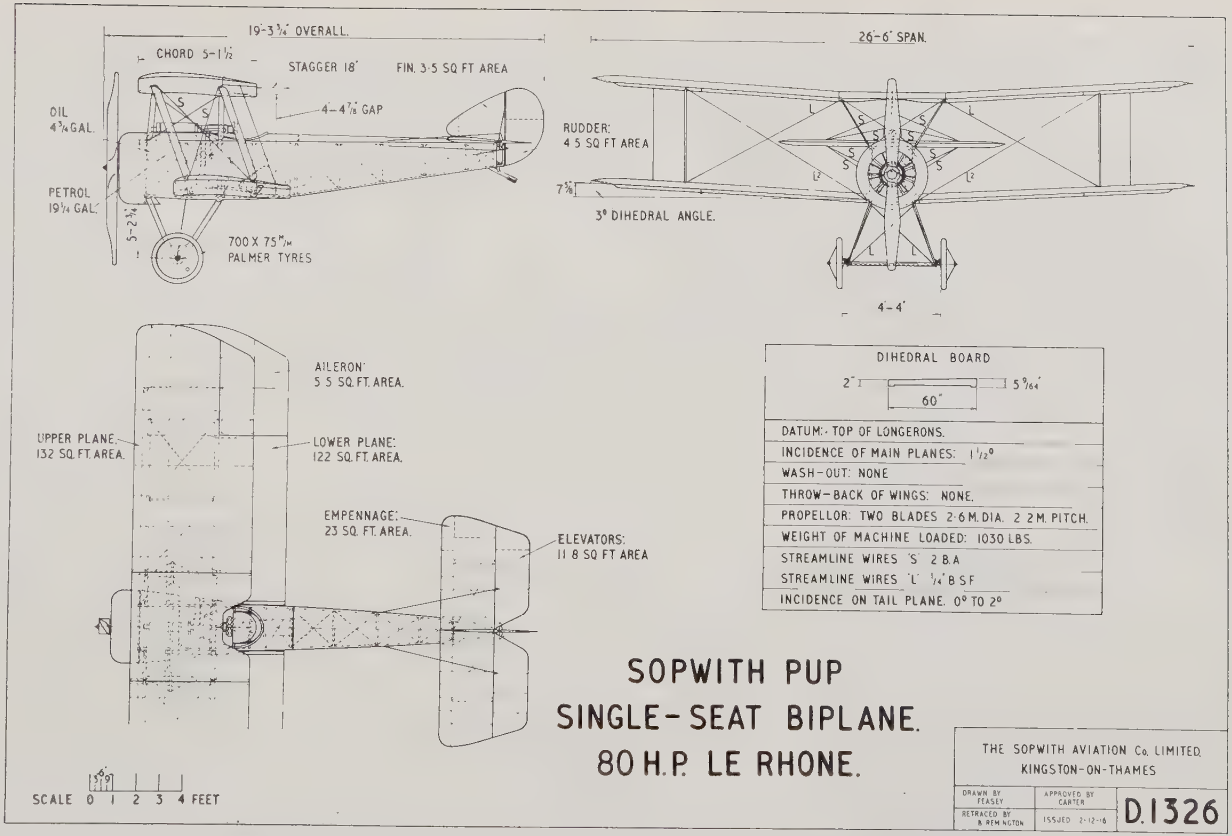
† *Early Bird* by W. G. Moore (Putnam).

An example of the Admiralty's initiative – the Sopwith Pup prototype derived from Hawker's S1.T.B.P. runabout. First flown in February 1916, it proved an immediate winner, and went into production without aerodynamic change. Not until September did production machines appear. (*Fleet Air Arm Museum.*)

again until the airspeed starts to slacken off. One lad refused to agree the Pup was weak and lost his wings – and life – over our 'drome trying to prove his point. It was a nasty sight, so we all went into the Mess and whooped it up with lots of booze.'

The hand of R. J. Ashfield is descernible in the design of the Pup, and its derivation from the Tabloid is clear when structural drawings of the two are superimposed. The length from stern-post to engine bulkhead is the same; the fuselages have identical depth; and the lower longerons are set at the same upward angle from rear spar to tail, though in plan the Pup is noticeably narrower. Vertical spacer-struts spindled to H-section are displayed in slightly different positions from the Tabloid, but the attachment fittings appear interchangeable, though Pup metalwork had more lightening holes. On a fuselage general arrangement drawing in my possession there is annotation by Fred Sigrist that the spruce longerons are to be changed to ash in subsequent versions. Wing construction of Pup and Tabloid show further similarities, for the chord is identical, the gap only fractionally different, and spar positions the same, but the Pup's wing stagger is seven inches greater.

Many features show how attentive Harry Hawker was to the draughtsmen's boards. The wing attachment was his design, and had the simplicity of a flying model of that day, for the butt of each spar was reinforced with a hollow metal ferrule within the end rib, and slid on to projecting ends of the centre-section spars and the lower spars traversing the fuselage. A long thin pin, with localized increased diameter at load points, was externally pushed through a tubular guide in the leading edge and through the spar abutments before emerging through the trailing portion of the



Original Sopwith drawing of production Pup showing backward-raked wing and tail tips. The large tailplane was responsible for unanalytical appreciation of flying qualities.

wing. An air-tight chordwise join resulted, simple and quick to secure compared with separate pin joints, enabling the wing cellules to be placed in position or removed while tautly boxed with bracing wires. The original patent was secret, but registered in Hawker's name as No. 113,723, and ultimately dated May 1917. So also was Patent 127,847, protecting the practical and extremely simple method of attaching the annular cowling of the 1½-Strutter and Pup, whereby an encircling groove, formed round the aft end of the aluminium cowl, engaged a similar groove in the nose structure of the aeroplane. A cable passed round the cowl groove and, tightened by turnbuckle, compressed the perimeter into the fuselage groove and locked it in position. It was a system quickly adopted by other makers.

Because axles slung between the inverted Vs of conventional undercarriages tended to become permanently bowed after several heavy landings, another simple solution was achieved in the articulated axles devised and patented (No. 109,146) by Tom Sopwith and standardized for all his machines. Using two separated horizontal spreaders from apex to apex, he pivoted the half axles between them from a central hinge, springing the hub ends with shock absorber cords wound on studs at the bottom of each undercarriage frame – but the crux of the invention was to suspend the central hinge by cable from the fuselage in order to resist collapse as the wheels moved upwards. Compared with sleeving the axle to increase bending strength, it saved several valuable pounds.

The Pup on early flights had a fixed tailplane like the Tabloid, but slight changes in trim with speed and pilot weight made a trimmer desirable for *finesse*. To use the nut and worm gear patented for the 1½-Strutter would be unnecessarily expensive, so Hawker devised a simple crank hinged from the stern-post, connecting it at mid-length to a vertical push-tube attached to the rear spar, and operated it with wires running from a diagonal sliding knob on the right side of the cockpit.

Ever since 1912 when Lieut Spenser Grey, RN, had interested Murray Sueter in Sopwith's first tractor made from a Burgess-Wright, the Admiralty had reposed unquestioning confidence in the company, purchasing most of their types. With the 1½-Strutter had come the opening Admiralty contract for the first specifically war-time Sopwith design, and soon a batch of 150 was well advanced at the extended Sopwith factory in Canbury Park Road. Six development Pups were now ordered by the Admiralty, followed immediately by a production order for the RFC at the instigation of Brancker.

C. G. Grey recorded that: 'The famous Sopwith works at Kingston continue to expand rapidly, cottages being pushed over and new buildings erected with extreme swiftness. It is quite fascinating to observe here and there, outside the walls of the main buildings, a floor laid down with enough benches for a few workpeople who carry on energetically while men are busily building round them and putting a roof on. No time is wasted, and the output reflects great credit on all concerned. Incidentally a number of girls are now employed in acetylene welding with highly


Fred Sigrist (left) who at 36 was already master architect of Sopwith production and a formulator of design. Harry Hawker (right) was a famous test pilot and also responsible for much Sopwith design. (*Photos. P. I. Capon and Flight.*)

satisfactory results. The organizing abilities of Mr R. O. Carey, backed by no less experienced a works manager than Mr F. Sigrist, have established a very fine factory, and Kingston must feel proud of the important part its local industry plays in the aerial development of the country.'

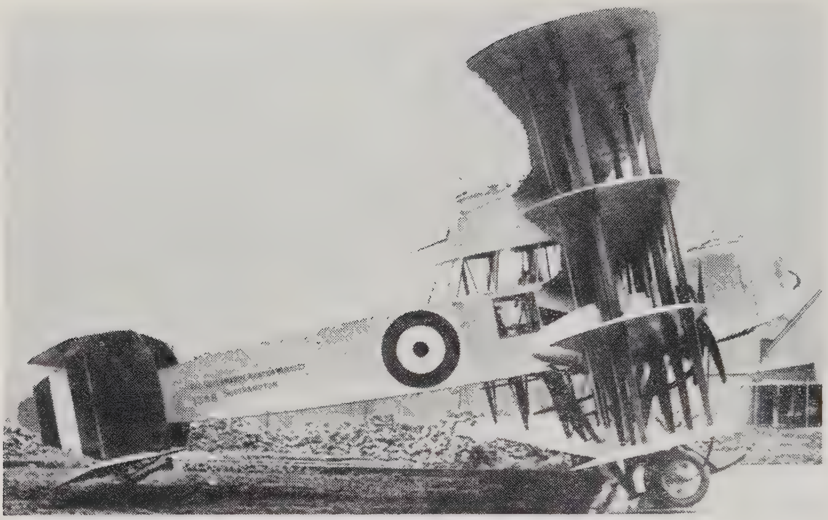
At a dinner given by the employees to the Sopwith directors celebrating the factory's third anniversary of its transfer from Brooklands, Sopwith particularly referred to Fred Sigrist and Harry Hawker as having 'the real credit for the Services using our successful machines', and Carey mentioned the excitement created by newspapers about the Fokker, saying that 'Great Britain, and Sopwith in particular, has something which would outstrip it any day – though if the Germans produced a machine of very high horse-power and short radius of action they in turn could beat it.'

The respective drawing office teams under Ashfield and Smith were so involved in new projects that the number of draughtsmen had to be swiftly increased. Among the entrants was W. G. Carter, who had been apprenticed ten years earlier to W. H. Allen & Sons of Bedford, and since 1912 had been engaged on engine design. 'My work as chief draughtsman at Sopwith Aviation in 1916,' he wrote, 'was mainly ensuring that experimental drawings were expanded and productionized so that they would be easily understood by inexperienced sub-contractors engaged on construction and assembly. I did not find it at all difficult in following aircraft techniques of design procedure, for they were not much other than an exercise in elementary aerodynamics and applied mechanics. As to the degree of responsibility between Smith and Ashfield, it was Herbert Smith who now became the chief architect of Sopwith design. No doubt he was assisted in conception of a type by Sopwith and Hawker, for both had a good eye for line and could be forthright in putting forward suggestions for him to consider. Ashfield, who was no thruster, was somewhat relegated to the wings, as it were, but was regarded as the key man should emergency arise.'

In the last three years the bespectacled R. J. Ashfield had played a major part in achieving Sopwith success, but he was too quiet, too diffident for big leadership and war-time politics. Undoubtedly many future projects were to receive preliminary layout from his hands. Meanwhile 'Mr Sopwith came into the design picture something like this,' Ashfield told me. 'He would walk into my section of the drawing office and call out "Ashfield! They" (that would usually be the Admiralty) "want a single-seater with a 110 Clerget, two Vickers guns, 1,200 rounds SAA, with 2 hours endurance and speed and climb so-and-so. Will you see what you can make of it?" I would scheme a preliminary GA and Mr Sopwith, Sigrist, and Hawker would hold a conference on it; then I would knock out a new GA as a result of their discussion. After one or two further tries, Mr Sopwith would personally take the final GA to the Admiralty or War Office. On return he would probably say: "All right, Ashfield, carry on. When can you get something into the shops?" Mr Sopwith was was always a joy to work for, giving praise for a good job, and not mincing words over a bad one. But after the storm, it was all over. Although Sigrist was an extremely good practical engineer he had no theory, and this was liable to let him down badly at times. He was not too easy to get on with, being rather prone to grouse, without realizing the difficulties, but if you cursed him back it usually worked out a draw. I must however stress that above all it was the influence and inspiration of Hawker which counted in all our designs.'

The private venture Pup, with its obvious potential as a swift and handy fighter, spelled the new look and ended the rival projects of several firms for escort fighter aeroplanes designed in the absence of interrupter gear or gun synchronizer. One was Pemberton Billing's ambitious but unhandy, twin-engined second quadruplane, the Night Hawk, which again endeavoured to solve the problem with a raised gun turret firing over the top

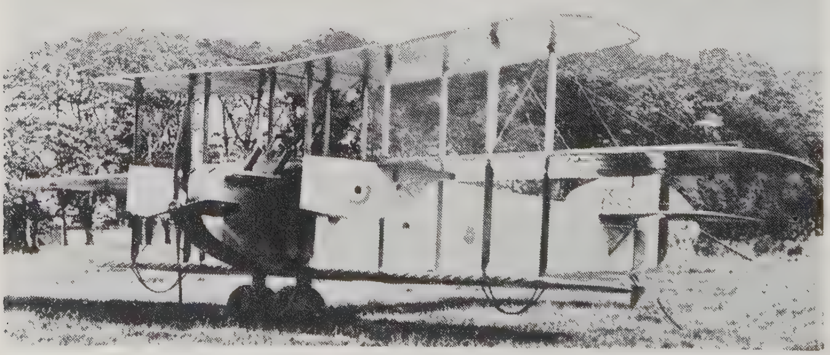
Particularly in fighters, essential upward view was often hampered by the centre-section. Here a Sopwith Pup has its centre-section covered with transparent Cellon. Wings are translucent doped to make them less visible against the sky. (*Fleet Air Arm Museum.*)



Pemberton Billing's Night Hawk, the drawings of which bear the signature R. J. Mitchell (later famous as the Spitfire designer) and, contrary to general belief, establish that he was a splendid draughtsman.

wing. Its builders, renamed The Supermarine Aviation Works, were now owned by Hubert Scott-Paine who had bought Pemberton Billing's shares when the latter was elected to Parliament following a successful attempt on the Hertford Division, and the firm was busy with a new pusher seaplane design. But P.B.'s idea of locating gun nacelles clear of the propeller had taken root and became the subject of single-engine versions which Armstrong Whitworth, Vickers, and Sopwith had recently built.

The first of these, representing Koolhoven and Noorduyn's unconventional solution, had already flown in the hands of Lieut-Cdr Peter Legh.



The second Armstrong Whitworth F.K.12. This was Koolhoven's solution to the problem of securing forward fire in the absence of interrupter gear. Gunners were carried in the outboard nacelles which were outside the propeller disc. (*G. Quick.*)

Referenced F.K.12, it was basically a high aspect ratio monoplane, with a shorter wing fitted above it and a similar wing below the fuselage, making a rudimentary triplane. A centre-line undercarriage with narrow track twin wheels was kept from tilting laterally by sprung wheels beneath the single-bay interplane struts. At the intersection of the cross-bracing wires, just outboard of the propeller tips, a nacelle was mounted on each mid-wing for the gunners. Despite one of the new 250 hp Rolls-Royce engines, performance was poor, and handling generously described as unsatisfactory, so the machine was now being rebuilt with deeper fuselage, modified trussing and greater area, underslung nacelles, and more practical undercarriage as illustrated.

The Vickers F.B.11 equivalent was an impressive, advanced looking biplane of 51 ft span, with undercarriage robustly modelled on the Avro 504. Remarkable for the single-bay arrangement in such long spars, its

The Vickers F.B.11 solution for an escort fighter was more conventional than the Armstrong Whitworth, and like the big Sopwith Triplane utilized a gunner's nacelle above the centre-section. Early Scarff rings were fitted. Endurance was 4½ hr. (*H. Busteed Photos.*)

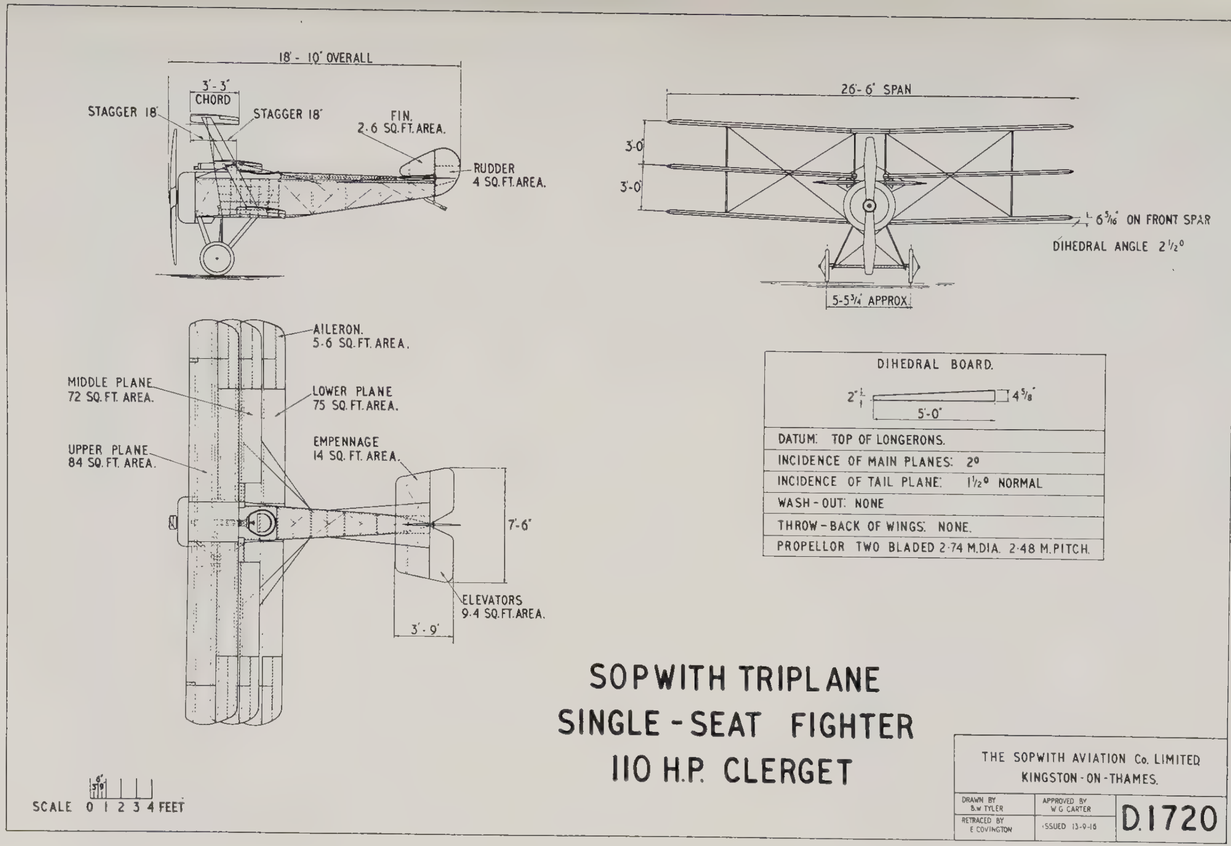
centre-section juncture overhung the widely splayed centre-section struts some 2 ft to bring it nearer the point of contraflexia – but the immediately arresting feature was the motorcycle sidecar-like nacelle mounted above the centre-section with nose supported by struts sloping down to the fore-part of the engine mounting, giving the gunner completely unimpeded fire in almost every direction. Unfortunately, like the F.K.12, this bulky machine could attain little more than 100 mph at ground level and 96 mph at 5,000 ft, so was already outclassed in fighting value.

The Sopwith L.R.T.Tr escort fighter was a 53 ft span triplane with chord of only 3 ft 6 in. Known as the Egg Box because of its streamlined gunner's nacelle, the Sopwith, like the Vickers and Armstrong Whitworth machines, was powered by a 250 hp Rolls-Royce Mk I. (*Fleet Air Arm Museum.*)

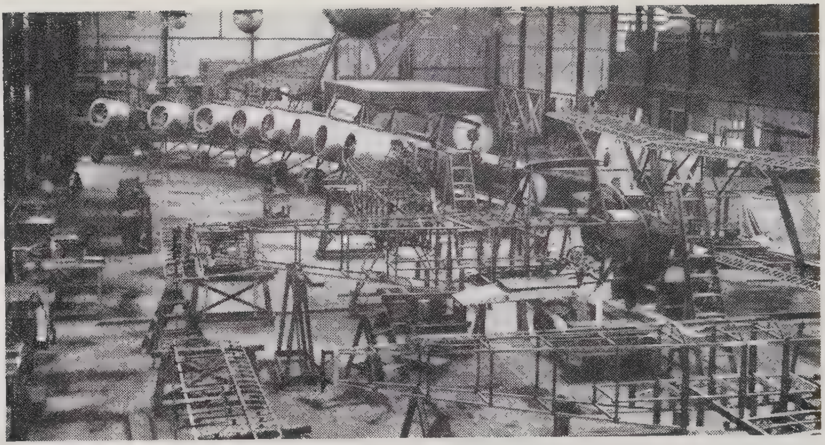
In similar category was the triplane, fractionally greater in span, built by Sopwith, and designated L.R.T.Tr in the Sopwith cipher system – or Long Range Tractor Triplane. Like the Vickers it had a gunner's nacelle projecting forward from the top centre-section of the novel, high aspect ratio wings, which had three bays of **I**-struts, the subject of Patent No. 127,858 by Fred Sigrist, comprising a wooden nose and tail held either side of a central H-section metal strut with bolts from nose to trailing edge. Known as the 'Egg-Box', the machine was no sooner completed than relegated to the Brooklands sheds as obsolete: but it had given the Sopwith team the idea of a triplane fighter, powered with the new 150 hp water-cooled Hispano-Suiza.

Accordingly Herbert Smith took as the basis a fuselage from the 1½-Strutters on the production line, and altered the forward structure to take a wing of 4 ft 3 in chord instead of the standard 5 ft 6 in, locating the lowest trailing edge approximately where the standard wing would be, and then staggered two wings above it until they balanced the estimated weight of the Hispano mounted on the unchanged bulkhead location used for the Clerget. But there was a long wait for the engine, and time gave rise to thought that the Pup might be similarly adapted with high aspect ratio wings, offsetting the interference of triplane configuration compared with the biplane, and giving better climb.

Superimposing the Pup fuselage drawing on that of the Triplane shows, as with the Tabloid, matched profiles, though the spacer-strut disposition



Original Sopwith drawing of Clerget engined triplane based on Sopwith Pup following experience with the L.R.T.Tr.



Sopwith 1½-Strutter production was allocated not only to Sopwith but also to Ruston Proctor, Fairey, Vickers, Wells, Morgan, Cooper, Mann Egerton, and Westland. Over 1,500 were built, and many more in France and Russia. Production lines were far from elaborate because of relatively small batches.

varies a little, with particularly clever adaptation at the centre-section struts. The span of the Pup and the Triplane was identical at 26 ft 6 in; the effective stagger from top leading edge to lower wing trailing edge was the same; and to align the three leading edges the wing chord of the Triplane was made 3 ft 3 in instead of 5 ft 1½ in. However, the weight of the Triplane would be at least 200 lb greater than the Pup; clearly it was desirable to go for the biggest available engine to enhance performance, so a 110 hp Clerget from the 1½-Strutter production line was taken. On 28 May the Sopwith Experimental Department passed the machine for flight tests. By that time the Pup was earning tributes everywhere for its impeccable handling, and one of the prototypes was in operational use in France to test its fighting qualities.

4

In mid-March the Under-Secretary for War announced the names of a Standing Joint Naval and Military Committee to co-ordinate design and supply of material for the two Air Services. The Earl of Derby was appointed Chairman; Admiralty representatives were Rear-Admiral C. L. Vaughan-Lee, Commodore Murray F. Sueter, CB, and Squadron-Commander W. Briggs, RN; War Office representatives were Major-General Sir D. Henderson, KCB, DSO, and Lieut-Colonel E. L. Errington. Colonel S. M. Hankey was Secretary, and the Assistant Secretary was Major Storr of the Committee of Imperial Defence. C. G. Grey commented: 'This is a move in the right direction, and not before it is wanted. It is a long way from the creation of an Air Ministry, but is a healthy sign that opinion is forcing upon those holding the reins of office the insistent demand for an Air Minister, and ultimately a separate Third Service to deal with

the ever-growing problem of how to keep Britain at the top in commanding the air.'

The French were facing a similar situation. So Louis Blériot had written to M. Clemenceau, who was Honorary President of the Ligue Aérienne Française, to urge better use of technically trained men. 'French Aviation,' he wrote, 'which until the beginning of hostilities was first in the world, is undergoing, if not a crisis, at any rate a retarded development. The reason is simple. The men who created the science have been eliminated from all technical committees, from supply programmes, and from direction. Let these men, who for the most part are aviators, engineers, and constructors, be given real technical control in collaboration with two or three pilots selected from the best of our fighting men.'

As a counter measure to mounting criticism in Britain, the Army Council decided on 30 March to appoint a Committee under Sir Richard Burbidge 'to enquire and report whether, within the resources placed by the War Office at the disposal of the Royal Aircraft Factory, the organization and management of the Factory are efficient, and to give the Council the benefit of suggestions on interior administration of the Factory which seem capable of improvement'. This was only eight days after Pemberton Billing had made an aggressive speech in Parliament alleging that 'the officials responsible for deciding types of machines for the RFC failed either by ignorance, intrigue, or incompetence to provide the best that this country could produce'. It seemed an echo of the almost personal vendetta which C. G. Grey had been mounting against Mervyn O'Gorman and the Royal Aircraft Factory.

Said Stanley Spooner, the white-haired founder-editor of *Flight*: 'We are frankly disappointed at what may be regarded as the really first attack on aviation in the House by Mr Pemberton Billing. We thought that the

The officers, Hampshire Aircraft Parks, Royal Flying Corps. Lieut-Col M. J. P. O'Gorman fifth from right in front row, with Major S. Heckstall-Smith on his right, and at end of row on left Capt F. M. Green. Extreme left top row is Major F. W. Goodden; in the middle row between O'Gorman and Heckstall-Smith is Capt S. W. Hiscocks, and Capt W. S. Farren is second from right. (*Royal Aircraft Establishment.*)

Member for East Herts had temporarily lost his head under the novel surroundings of Westminister, but subsequent utterances and public sayings deny this charitable explanation of his unnecessarily vehement language. There can be no question upon one outcome: he has lost the sympathy of many prepared to listen to his claims and wholeheartedly support the imperative cause of aviation. Probably no MP ever entered Parliament with more promising cause than Mr Billing – a cause which only needed firm handling and plain speaking to ensure a splendid reception. Goodness knows he had enough solid facts without resort to hysterics; but wild accusations of murder may take a lot of explaining when strict proof is called. It would be well for him – it certainly would be for aviation – in good time, and before too late, to weigh well the expediency of continuing to draw inspiration from whatever source may be feeding dangerous fuel into the too ardent flame of criticism which burns spontaneously within him.'

What Billing had done was to quote, in a somewhat lurid speech, a wild accusation made in the House by Colonel Walter Faber, a Conservative of the old school, that RFC pilots were being 'murdered rather than killed' by inadequate equipment. He had been backed by another eminently respectable Conservative, that lawyer and pillar of the Church, Mr Joynson-Hicks, who in pre-war days created a show-down over the RFC's deficiencies and recently read to the House a letter from a friend in France which said: 'How regularly these official reports seem to me to lie as to our mastery of the air.'

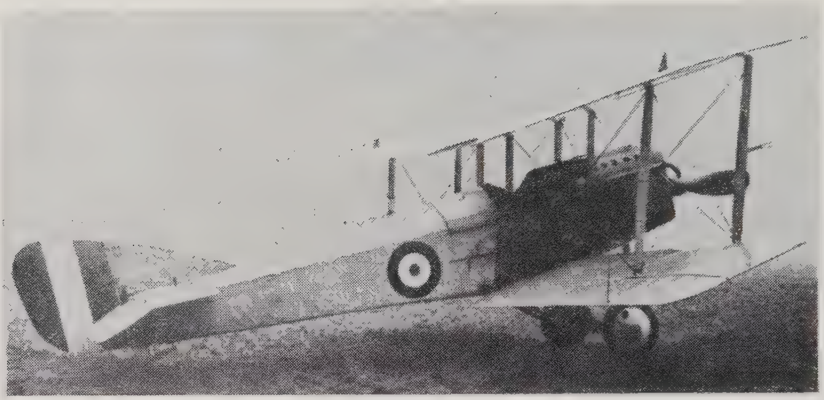
The imaginative, forceful Pemberton Billing took these comments as his theme, and accused the authorities, by which he meant General Henderson and Mervyn O'Gorman, of committing a fatal blunder in standardizing the B.E.2c. He ignored that there had been no better machine, nor any with such adequate drawings and schedules. Billing was intransigent, repeating again and again Faber's charge that pilots were being murdered, elaborating it with stories from men on active service. The Press turned to him with relish, and he was strongly backed by Lord Northcliffe through the columns of his *Daily Mail* – for Billing had blown orthodoxies sky-high in a manner delighting the public and giving them something interesting to read.

Yet his outbursts could not disturb the smooth tenor of Parliamentary ways. Introducing the Navy Estimates, Arthur J. Balfour, First Lord of the Admiralty, welcomed back from active service at the Front Colonel Winston Churchill, who 'long before the use of aircraft had been proved by experience, foresaw the part they were going to play in Naval warfare, and set himself to lay the foundations of a Naval Air Service'. Turning to special requirements of that branch, Balfour expressed conviction that it had been an immense gain to have two separate departments for naval and military aviation, though he thought it wrong that 'people came to the decision that it was not worth our while to deal with the complicated and costly question of Zeppelins'.

During the ensuing debate, Winston Churchill said: 'There is a matter which I cannot avoid mentioning, although I shall do so in language of the utmost precaution. A strategic policy for the Navy purely negative in character by no means implies that the path of greatest prudence is being followed. I wish to place on record that the late Board of Admiralty would not have been content with an attitude of pure passivity during the whole of the present year. There is one other cognate matter which illustrates what I mean. We hear a great deal about air raids. A great remedy against Zeppelin raids is to destroy Zeppelins in their sheds. I cannot understand why all these months, with resources far greater than those which Lord Fisher and I ever had at our disposal, it has not been found possible to continue the policy of raiding which in the early days was carried on, and send a handful of Naval pilots to Cologne, Düsseldorf, Friedrichshafen, and even to Cuxhaven itself.'

There was no great reason for more than passing concern of the aircraft supply position, for the great organization of war was being steadily augmented. It was the hugest piece of national machinery ever operated, so there were bound to be inefficiencies and errors and even disasters – but the sheer multiplicity of effort concentrated upon any and every aspect was bound to produce an article, an invention, or other device fully compensating for money spent on less successful efforts directed to the same end. Thus new designs of aeroplanes were beginning to proliferate. Since there was no certain knowledge of factors making an aeroplane liked or disliked, or assuring adequate strength, or accuracy of performance prediction, it was a case of 'many are called but few are chosen'. At any time there were now at least a score of aeroplanes being designed, and half a dozen might be under current development. Except to senior Admiralty and War Office officials closely concerned with consideration of new designs or of placing orders, the curtains of national security and manufacturing secrecy prevented anyone knowing fully what was being built and where. Occasionally it was discovered by accident, such as a few weeks earlier when a newspaper reported that: 'On Monday Mr Raynham was testing a new and very powerful type of Martinsyde Scout, which must not be described beyond the statement that it has a long and somewhat tapering fuselage. Several loops were followed by an evolution which was not so much a loop as a back somersault, and it was then seen that the tail of the machine was at right angles to the wings. The machine did a curious whirling sideslip, turned on to her back, parachuted quite slowly from about 500 ft to within 100 ft or so of the ground, and then did a nose-dive upside down, falling into a soft muddy patch in the corner of the field between the track and crossroad where the Chobham, Byfleet, and Weybridge roads meet, the right wings overhanging the footpath and the tail resting on the hedge. Mr Raynham was promptly taken to the Weybridge Hospital suffering from concussion but no bones were broken, though his face was badly cut.'

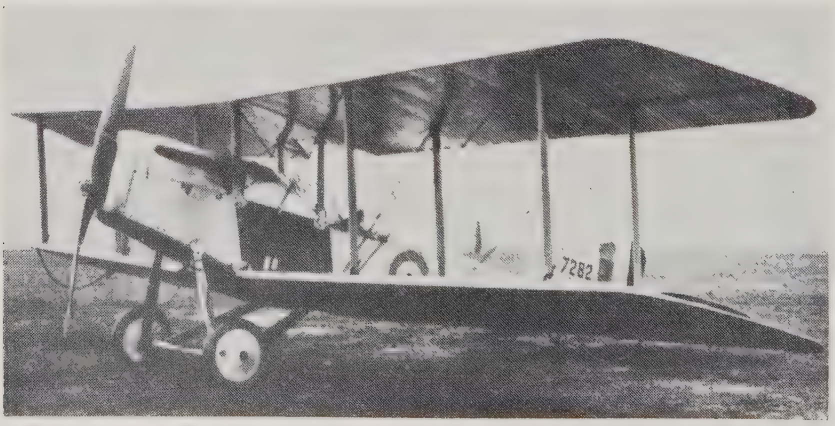
A few days later Tony Fletcher was discovered at Hendon in the London Provincial Company sheds, 'the inevitable cigarette between his lips, hard



The Martinsyde 'revised' G with which Raynham may have crashed. Whether it had a Hispano-Suiza or a Rolls-Royce engine is not certain. There was another version with Beardmore engine which located the pilot behind the centre-section. Both had a basic Martinsyde Elephant fuselage. (*Courtesy The Royal Aeronautical Society.*)

at it laying out the fuselage of his new tractor biplane'. He told me ten years later that Raynham's crash was with the 'revised' G which he had drawn and stressed before he left – though J. M. Bruce considers Raynham was flying a standard G.100, and in any case there may be confusion with the R.G. reference. Certainly a score or so G.100 production machines had been completed by then, and on 1 March No. 27 Squadron arrived in France with eleven of them each equipped with a Lewis gun on a centre-section tripod. Within four months the 160 hp Beardmore was being tried with intention of subsequent substitution for the later production versions known as the G.102 Elephant.

Whether Handasyde had secured a 150 hp Hispano for the so-called



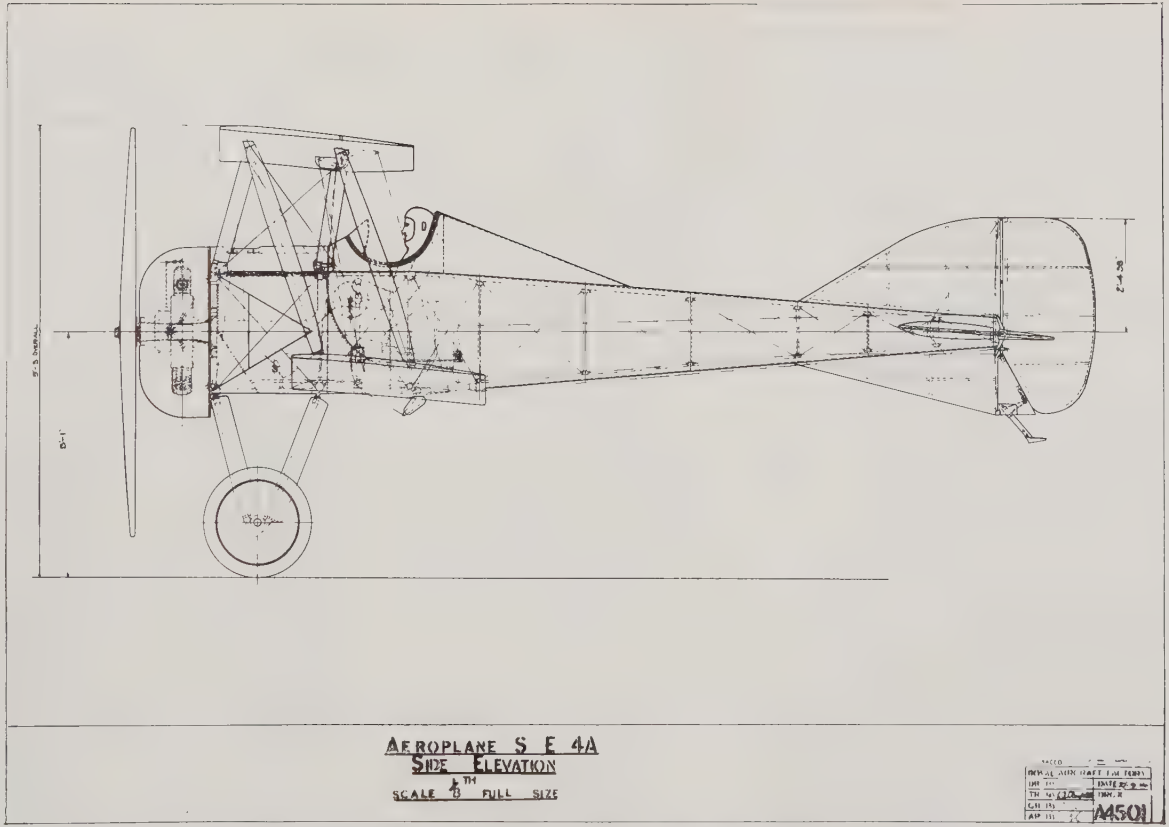
The standard production Martinsyde G.100 Elephant differed in minor details from the prototype. A few were in France early in 1916 as escorts for two-seaters. A Lewis gun was mounted above the centre-section and a rear-firing Lewis behind the cockpit.

'revised' G is not clear. This French-built engine had been designed the previous year by Marc Birkigt, a Swiss, and was remarkable for its power, clean design, and weight of only 445 lb. Lieut-Col H. R. M. Brooke-Popham, while in charge of RFC supplies in the Field, inspected the prototype in Paris during the summer of 1915, and on his recommendation the British War Office immediately offered a contract for 50 engines but required a licence to manufacture in Britain. Negotiations typically took time, for the French company was already manufacturing under contract and matters must be referred to headquarters in Barcelona. Meanwhile the Wolseley Motor Co Ltd was selected as potential manufacturer in England, for the Royal Aircraft Factory had been instructed to produce a fighter powered with this engine.

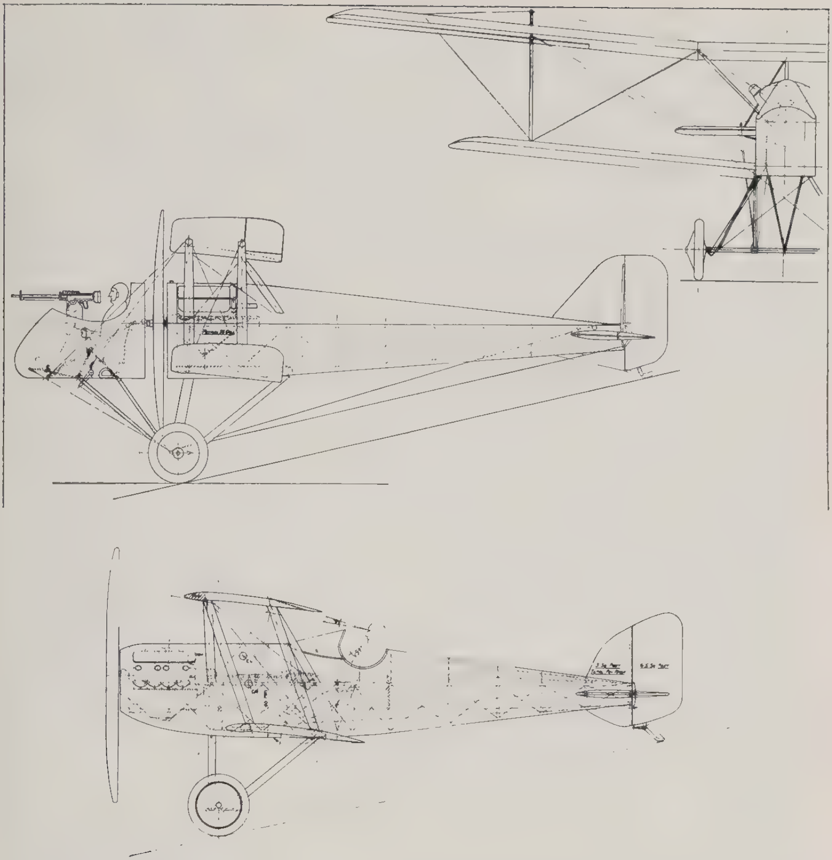
Sir William Farren, who joined the Factory on 1 May, 1915, recalled that: 'Our real chance came with the 150 hp Hispano-Suiza engine ordered in August 1915. Early in 1916 the chief engineer, Fred Green, and I, as chief aerodynamicist, were summoned to Mervyn O'Gorman's office to meet General Brancker, and were told he had the offer of the French Hispano, and would we like to try to make a single-seater fighter with it? We jumped at the idea. The outcome was the S.E.5 and its followers – essentially the same aircraft, but with progressively more and more powerful engine. Folland was head of the group in the design office which handled the S.E.5. I remember almost daily tours, accompanying Green, looking at schemes and drawings. Kenworthy, who was the chief draughtsman in the accepted sense of that term, often came with us.

'For each new design there was a group of designer-draughtsmen under a good leader responsible for translating the general scheme into working drawings, both general arrangements and details, but the overriding authority was F. M. Green. There is a crystal-clear picture in my mind that everything, whether aircraft or engines, was to his ideas and final decision. He inspired us all. There is an impression in the minds of people who were not there that he had far less influence and authority than he had in fact. It is only natural that the senior design-draughtsman on each project became identified with it; but to ignore the personal influence of Green gives an entirely misleading picture of how the Royal Aircraft Factory worked. He was in every sense the chief engineer.'

It is possible that the compact design of the S.E.5 was inspired by the undefined 'revised' Martinsyde G, for though months passed before a second prototype of the latter appeared, redesigned for the 190 hp Rolls-Royce Falcon, undoubtedly Handasyde would have shown his first machine to Brancker. Indeed the actual flights of new aircraft could not often be hidden even if design had been secret, for places such as Brooklands were still public, and gossip passed from friend to friend in different companies. In fact the Farnborough team had already considered a preliminary fighter design, the F.E.10, based on the B.E.9 and its gunner's 'pulpit' in front of the propeller. A similar scheme had been patented in 1915 by the Deperdussin designer Béchereau for a two-seat fighter Spad.



Original drawing of the third S.E.4a, which was flying in July 1915 and may have influenced Sopwith in proceeding with the Pup. (*Royal Aircraft Establishment*.)



The B.E.9 'Pulpit' principle was sufficiently successful to apply to a single-seat fighter, the F.E.10, but with development of gun synchronizing gears it was expedient to modify the general layout to a conventional tractor by altering the stagger and moving the engine forward. (*Royal Aircraft Establishment.*)

Some time in May the F.E.10 was abandoned, and at Major Frank Goodden's instigation – that tall and smiling 24-year-old Chief Test Pilot of Farnborough – a compact tractor was commenced which seems an amalgamation of features from the Martinsyde and the rotary-engined S.E.4a Folland designed in 1915 in sequence to the B.S.1 originated by de Havilland. It was schemed by overlay tracing of the F.E.10 proposed fuselage structure and undercarriage; relocating the lower wing a bay back; removing the engine from the fuselage bay under the centre-section; converting the radiator position to a bulkhead, and attaching the engine at this point to give a conventional tractor. The F.E.10's contemporary B.E.2e type wings with long top overhang were changed for equi-span wings revealing the ancestry of Folland's S.E.4a.

Westland-built Sopwith 1½-Strutter on the unfinished factory airfield.

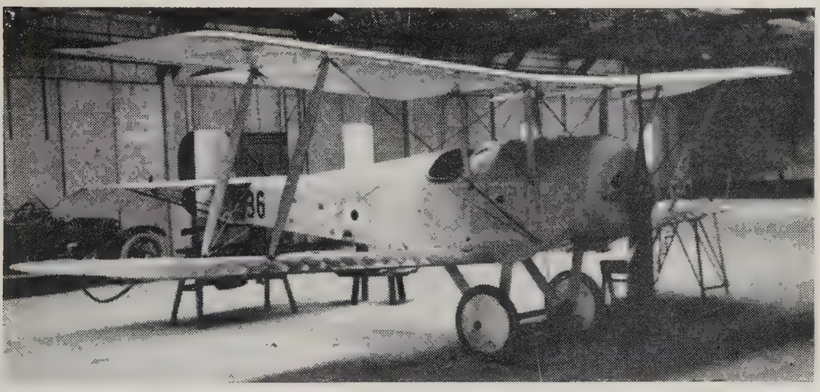
Fighters had become a major interest with several companies. Following the success of the 1½-Strutter, Alliott Roe had led Chadwick to make a two-seater of similar geometry which looked like an ungainly single-bay version of the 504 and used many of its components. Tested by Raynham, it showed no points of superiority, but achieved a 'second string' order for 25.

At Filton, Capt Frank Barnwell was virtually filling in time by designing a small side-by-side two-seat armed scout, the S.2A, which appeared in May as an undistinguished cross between the original Sopwith Tabloid and a scaled-up version of his own Bristol Bullet. Recently he had gained a technical assistant in Leslie Frise, who had been transferred to Bristols from the Royal Naval Air Service where he was making his mark as a

The Avro 521, with 110 hp Clerget, was designed for fast production using Avro 504 basic parts. Proposed variants had standard 504 mainplanes or wings of 46 ft span according to rôle. (*Crown copyright reserved.*)

technician. He represented the new generation of aeronautical engineers who had been schoolboys before the war. As a youngster he spent many a half-day holiday sitting on the flying-field fence at Filton, waiting hopefully for a Boxkite to fly. From school he entered Bristol University determined on aircraft design, and graduated in the 1915 summer term.

Even before completion, the Bristol T.T.A. twin-engined fighter had been rendered obsolete by the interrupter gear which made single-engined fighters feasible. Because of this the proposed twin 150 hp RAF 4a engines were now diverted to the single-seat night-fighter version of the B.E.2c known as the B.E.12, and oppositely handed 120 hp Beardmores substituted. Early in May both the T.T.A. and the two-seat S.2A were ready for trials by Capt Hooper, RFC, who had been attached to the company for a 'rest' in the guise of test pilot, but by now results were only of academic interest.



The Bristol S.2A had a span of just over 28 ft and, like the Avro 521, was designed as an alternative to the Sopwith 1½-Strutter, but was flown some two months after the Sopwith. (*Bristol Aeroplane Co.*)

Barnwell had already schemed a pretty, crescent-winged monoplane fighter representing an improved version of the Morane-Saulnier 'Bullet' he had flown in France and liked as a fighter. Neither Admiralty nor RFC were disposed to take the design seriously, for those in official circles still believed monoplanes were highly dangerous because they had been banned at O'Gorman's instigation after the Military Trials of 1912. However, Barnwell was certain that his clean monoplane, powered by the new 110 hp Clerget rotary, would give far greater top speed than the pretty little Pup for which Sopwith was receiving extensive and urgent orders. Barnwell therefore urged the Bristol directors to permit a prototype as a private venture, and construction was well advanced by the time the obsolete S.2A was flying.

Designers are imaginatively restless: for every aeroplane built they will have schemed 10 or 20 others, with variants for specific needs. The need for a powerful two-seat reconnaissance fighter to replace the 1½-Strutter had been in Barnwell's mind ever since the October design–liaison meeting

at Farnborough. Sketches for an R-class Bristol assumed something of the shape of the G.E.2 biplane which he saw his company build to Gordon England's design for the 1912 Military Trials Competition with the fuselage a foot or so above the lower wing, but by placing pilot and observer behind the centre-section there would be a better fighting view above the top wing than from any other two-seater. His first drawing showed a long overhang to a single-bay top wing, similar to the R.E.8 which he knew the Royal Aircraft Factory was designing based on the B.E.2e; but Barnwell's design soon developed into the R.2a with equal-span wings and a 120 hp Beardmore engine. Promising though the design was, with pilot and gunner placed very close together and fuselage tapered to a horizontal knife-edge to improve the aft field of view, it was clear that performance was compromised by inadequate power, and in May, Brancker offered one of the new 150 hp Hispano-Suizas. Temporarily design reverted to a long top wing overhang using a single-bay structure, adding an outwardly raked pair of struts to carry the overhang. But Barnwell was not satisfied. There were reports that the new Rolls-Royce of 190 hp would soon be available, and again he became engrossed in redesign using two-bay wings.

The Bristol T.T.A., illustrated, was the same length as the D.H.3, but the span was 7 ft less though the area was nearly 50 sq ft greater. The speed was 87 mph compared with 95 mph for the D.H.3. Rates of climb were similar. (*Bristol Aeroplane Co.*)

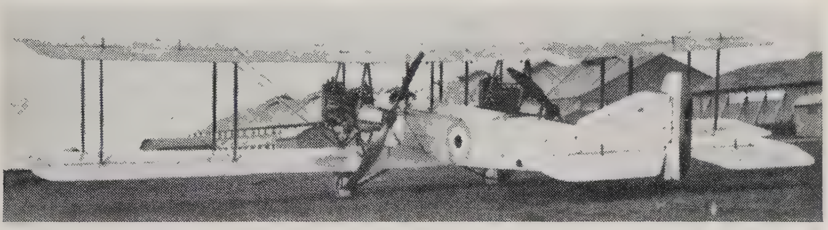
Late in May the twin-engined Bristol T.T.A. went to Upavon for official handling trials, but it was not greatly liked, pilots particularly criticizing lack of view from their cockpit behind the wings, with long nose ahead, and deep engine nacelles like blinkers each side. Lack of intercom between pilot and gunner made co-ordinated fighting tactics impossible, and controls were uncomfortably heavy, with poor response when banking.

5

By now the Navy's Avro 523 bomber, named the Pike, was also ready for testing. Powered by twin 160 hp Sunbeams conventionally mounted at the inboard bay, midway up the gap, it had pusher propellers driven by extension shafts in order to get the engines well forward in the wings, showing uniformity with the F.E.4 and D.H.3 both in this respect and in

dispensing with the usual twin-wheel undercarriage unit under each engine, using instead a single undercarriage frame and wheel each side, with axles swept up to a fuselage resting conventionally on the lower wing. The pilot was ahead of the centre-section, and the gunner had a cockpit in front following the well-proved arrangement of conventional tail-boom pushers. Apparently uninfluenced by the Avro 519 single-engined bomber built earlier in the year, the entire conception was a remarkable achievement as the first sole design responsibility of young Roy Chadwick.

Taken on its first flight in May by Fred Raynham at the new Hamble airfield which A. V. Roe had acquired adjacent to Southampton Water, the machine attained 97 mph and climbed 5,000 ft in just under 10 minutes. After a few flights it was sent to the Admiralty Experimental Establishment on the Isle of Grain, where early in the year an Experimental Flight Section was established, originating with the attachment of a single Flight Sub-Lieutenant for seaplane testing, and was now commanded by Commander Seddon for all flight test work.



Closer in conception to the D.H.3 was the Avro 523 Pike, with horizontal-tier bomb stowage designed by Alliott Roe. However, the company received an order for a heavier version which became the Avro 529.

Here trials were conducted by Raynham to demonstrate the handling qualities of the 523 ballasted with C.G. first forward and then full aft, but the latter required maximum strength to push the control forward to overcome extreme tail heaviness, and when the engines were throttled it became impossible. Raynham was carrying a youth called Roy Dobson, known as 'Dobbie', in the rear cockpit midway between the wings and tailplane. Beckoning vigorously he induced him to clamber along the fuselage, despite absence of handhold, until he got into the nose gunner's cockpit and re-established more forward C.G. where control was restored and danger of stalling averted. This cocky, confident, round-faced youngster had caught A. V. Roe's attention when interviewing draughtsmen applicants in March 1914, and he seemed good material, though somewhat vague on scholastic qualifications.

'Have you done any drawing?' asked A.V.

'Yes,' said the smart young man, failing to reveal he knew nothing of *mechanical* drawing.

'Right,' said A.V. 'I'll send you in to Mr Parrott.'

'At that time Chadwick was chief designer, and I went under him as one of his draughtsmen, but did not stay for long – six months, and then

was sent to the Test House on material,' Sir Roy Dobson told me fifty years later, omitting to explain that he proved rather unsatisfactory as a draughtsman. 'Chadwick was a very outstanding personality. The men running the company were R. J. Parrott as general manager, Chadwick as chief draughtsman, and C. R. Taylor as chief technician. Harold Rogerson and Frank Vernon were the mathematicians and stressmen, and they were both excellent at their jobs. A. V. Roe himself was chairman, and although dear old A.V. was always messing us about, he never really designed anything in the Avro 500 series. Before Chadwick became chief designer, Parrott was in that job, and he was a really first-class engineer. He and Chadwick certainly led the whole team on the 500 series. When R. J. Parrott was made general manager, Chadwick became chief designer, but I don't think "Chad" ever learned much in the technical sense from A.V. He got the basis of this in his early training at Metropolitan Vickers in Trafford Park, Manchester, and followed that up by his own studies at Manchester School of Technology, and became really quite a good mathematician.

'The 504 was never the hit and miss affair that a lot of people make out, and I know this from the personal experience of being very closely mixed up with it. Like any other good thing it was full of sound engineering. I think the actual drawings were done by Roy Chadwick, C. R. Taylor, Cliff Horrocks, Norwood, and Pemberton. The "state of the art" in the D.O. was much more mathematical than aerodynamic, but Chadwick and Harry Rogerson had rapidly gathered much aerodynamic knowledge, and Rogerson became quite an authority on airscrews.'

In two years of war A. V. Roe had considerably expanded, even pioneering wasteland development by purchasing a triangle of hill slope conveniently alongside a railway, and dumping thousands of tons of spade-lifted earth to level it for buildings. But A. V. dreamed of a garden city on the south coast – modelled like the Petters' ideal on the factory and village of Bournville – and while motoring in search of a site around the coastline opposite the Isle of Wight, discovered Hamble and its spit of land between Hamble River and Southampton Water. Within a fortnight he secured his co-directors' agreement to buy 100 acres for an aerodrome and a mile of foreshore as a seaplane base. On the edge of the biggest field, a few hundred yards from the shore, a splendidly designed, large rectangular building was erected, and drawing offices built with the immediate intention of conducting experimental development there, leaving the Manchester works to concentrate on production.

'The works at Hamble were under the control of R. J. Parrott, a good all-round engineer, who moved south before the general transfer, leaving H. E. Broadsmith in charge of Manchester works,' recollected Roy Chadwick's technical assistant, 'Jock' Ratcliffe. 'Another of A. V. Roe's brothers, the Rev E. V. Roe, was for a time general manager at Hamble, though later became Vicar of Hamble Parish Church. F. G. Clifton was aerodrome superintendent, responsible for aircraft undergoing trials, and it was with him that I first encountered Roy Dobson, who was the aircraft

mechanic looking after new types undergoing flight trials at various aerodromes and latterly was based at Hamble. His was a very daring act to crawl from rear to front cockpit along the decking of the Pike between the rotating engines. Raynham was then just able to slide-slip and land safely, but it was Roy Dobson who saved disaster. Soon after, Dobson was caught and chastised by Parrott for assembling in his spare time a Ford car in one of the sheds left by the builders of the new Hamble works. Consequently he left Hamble, but persuaded John Lord, who with Humphrey Roe was joint owner, to give him a job again at the Manchester works. It was not long before he became assistant to the manager and presently works manager there – and with his work, guts and untiring energy steadily rose to his great position in the aircraft industry.'

The D.H.3. Initial production of 50 had been intended. They would have had 160 hp Beardmore engines and been without the extension shafts used in the prototype. Span was 60 ft 10 in compared with the Avro Pike's 60 ft. Empty weights were identical and endurance was sufficient to bomb Rhine cities from north France.

Before a decision could be taken on the Pike's future, Geoffrey de Havilland was testing its military rival – the fighter-bomber D.H.3 which had two Beardmore engines of only 120 hp compared with the twin 160 hp of the Pike. The entire machine gave the impression of robust strength, typifying the mark of Charles Walker's stressing, but although the same empty weight as the Avro was attained, the D.H.3 carried 230 lb less load due to considerably smaller horse-power, yet speed was almost identical. So promising were the results that two 160 hp Beardmores were issued for the second prototype, and as they were longer it was possible to eliminate the original extension shafts, though a cut-away trailing edge was necessary to clear propeller tips. Walker explained to me that the new propeller position set up tip flutter because one object in using the low fuselage was to enable the engines to be set closer inboard than usual, and the bigger propellers for the more powerful engines resulted in their tips becoming only a few inches apart. A practical cure was found in a foot-deep plywood strip between front and rear centre-section struts and extending behind the trailing edge. The somewhat better powerplant gave the D.H.3A speed and climb exceeding the Avro Pike, and the testing squadron at Upavon recommended acceptance, resulting in a contract for 50 machines; but although work was started, current and projected single-seaters with interrupter gear spelled the end of twin-engined fighters and

The F.E.4 was originally schemed at the beginning of the war for ground-attack, and was of remarkably advanced conception. Daringly there were no centre-section struts at the fuselage. Small fans assisted cooling. Capt Goodden is at the controls.

the contract was abandoned in favour of Geoffrey de Havilland's proposals for a reconnaissance day bomber which he had been discussing with the Air Board in the person of Colonel Beatty.

At the Royal Aircraft Establishment the F.E.4, source of D.H.3 inspiration, was in final stage of construction, and on completion was found a little lighter than the de Havilland, despite its larger span of 75 ft and the weight added by hingeing the downward-folding top extensions and outwardly raked end struts. With its biplane tail and extreme nose location of the pilot, the Farnborough machine seemed clumsier and less logical than the de Havilland, but there was little difference in performance nor any great attempt to improve it as both aircraft were destined for the scrap-heap.

More than a month before these machines flew the second and much redesigned Handley Page O/100 was ready. Flown by the new Handley Page test pilot Clifford Prodger, an American who had learned to fly at the Beatty school only a year before, results seemed very promising, and with customary zeal for publicity, H.P. decided he would demonstrate the machine's lifting ability to the world by establishing a height record. On 23 April, with pilot and ten passengers, the useful load totalling 3,500 lb, the O/100 climbed to 10,000 ft in 39 min 45 sec, which was barely 10 minutes slower than the F.E.4. Elated with success, H.P. arranged for acceptance trials with Admiralty technicians present on 7 May, but this time he dramatically marched volunteers one by one into the machine until there were sixteen in addition to the pilot, but did not disclose that fuel was only 45 gal in the total load of 3,395 lb. There was a reasonable

take-off run, and the machine climbed to 3,000 ft in 8 min 24 sec. A world's record had been established, and the Navy was temporarily delighted.

Flight reported the return of the second prototype to Hendon at the end of April saying that: 'The feature of the day was the literally flying visit of the Handley Page biplane, *alias* "Flying Elephant", but a vastly different class of machine to the famous Brooklands "Elephantoplane" of pre-war days. It was a strange and wonderful sight to see this machine come gliding majestically along, with scarcely a sound from its engines of goodness knows what hp, and alight on the aerodrome at certainly not more than 20 mph. An L & P biplane passed close by at the same time, and afforded an opportunity for interesting comparison. After the "Flying Elephant" came to rest, a trap-door in the body opened and our old friend C. B. Prodger was lowered on to *terra firma*, and then his mount was replenished with petrol – a process which made one cease to wonder why we are told not to use a motor-car for pleasure when one saw so much fuel put into one machine. The interval for refreshment of the machine being over, Prodger took it up and made a couple of circuits and a little later took the monster back to its den.'

On 27 May Eastchurch pilots took over, flying No. 1456 from Hendon to their aerodrome. Intent on compass course they found the machine behaved differently from the previous one and, after landing, a conference between Commander J. L. Forbes as Officer Commanding, the pilots, Handley Page and Volkert, led to the conclusion that the lengthened nose had impaired directional stability, and it was decided an additional fin should be tried.

Three days later it was ready, but attempts at full-speed runs revealed

The eventual production Handley Page O/100 had the elevators left overhung and shorn of their balances. In this form, with nose and mid-gunner locations, forty-six were built before switching production to the improved O/400—one of the great aircraft of history. (*S. T. A. Richards.*)

the tailplane oscillating in the same way as prototype No. 1455, though not until at higher speed. When it came to trying the machine with full load it was discovered that the moment of leaving the ground produced another marked tail oscillation, proving so violent on one take-off that an immediate landing was made in the limited area available. The O/100 was then taxied to the extreme end of the ground and another attempt made, this time being held down until a much higher speed had been attained, when it was found that trouble did not recur.

Further tests showed the fin had not cured directional wandering. H.P. was loath to believe that still greater fin area was needed, and recollected there had been similar trouble with Russia's giant Sikorsky which apparently was cured by turning out the trailing edges of the balanced rudders 'in order to give a grip on the air'. He decided to try toeing out the O/100 rudders by 3 inches. To the dismay of everyone, even greater directional instability ensued, and at high speed the machine yawed from side to side violently. It seemed Handley Page and his team had a big problem in more ways than one. Patiently Volkert began complete redesign of the fuselage to give greater stiffness and rigidity.

6

The Excess Profits Act was causing widespread concern particularly to those forced to expand their business considerably if they were to make effective contribution to the war effort. George Holt Thomas wrote to several leading aircraft manufacturers proposing that an association be formed so that constructors could speak with one voice to Treasury and provisioning officials. On 29 March this private group registered 'The Society of British Aircraft Constructors', incorporated as a company limited by guarantee and with no share capital. Its first meeting was held on 13 April to elect a Committee of Management consisting of H. White Smith, British and Colonial Aeroplane Co; Major H. F. Wood, Vickers Ltd; R. O. Carey, Sopwith Aviation Co; G. Holt Thomas, Aircraft Manufacturing Co; Howard T. Wright, J. Samuel White & Co; H. V. Roe, A. V. Roe & Co; E. B. Parker, Short Bros; L. Coatalen, Sunbeam Motor Car Co; and E. W. Petter, Westland Aircraft Works. H. White Smith was unanimously elected chairman of the Council of the Society, whose principal objects were 'to encourage, promote and protect the British Aircraft Industry and to act as the Representative of the Members of the Society in matters affecting industry'. Ordinary membership was strictly confined to constructors of aircraft and aircraft engines, but associate membership would be available to makers of accessories or those in allied trades. The entrance fee for ordinary members was £30 with annual subscription of £20, and for associate members £15 with annual subscription of £10. Charles V. Allen was appointed secretary with an office at St Stephen's House, Victoria Embankment, London, SW1.

Shortly after the inaugural meeting a list was published of the 41 companies who had notified intention of joining. Of these only ten were

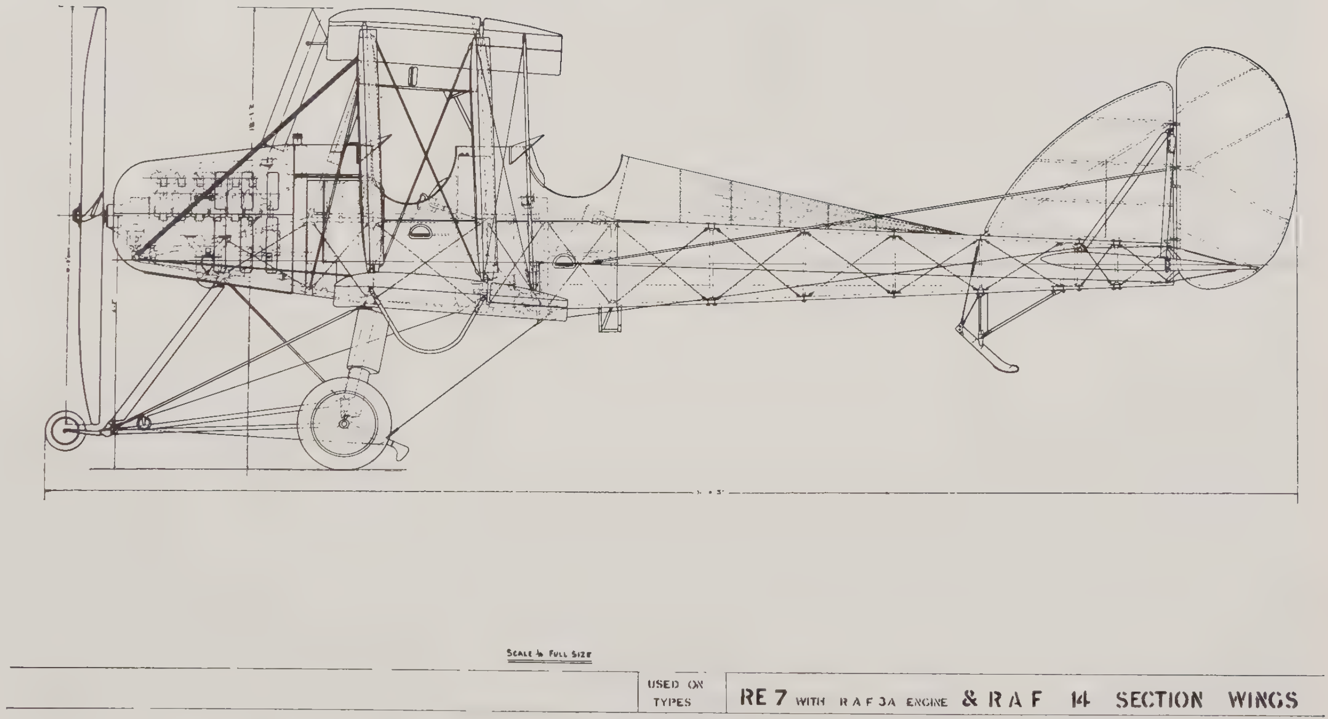
aeronautical pioneering firms, and the others had diverted to war-time aircraft production. (See Appendix I.) Although eight major motor-car manufacturers joined the Society, other engine producers decided to form their own business union and registered the 'Association of British Motor and Aircraft Manufacturers Ltd' of 173 Fleet Street, London EC, with 100 members each liable for £1 in the event of winding up. Most smaller firms and accessory manufacturers joined, and management was vested in an executive committee of which the first members were E. Manville, as chairman of the Daimler Co Ltd, and A. Sperrier as director of Leyland Motors (1914) Ltd. In effect it was an offshoot of the Society of Motor Manufacturers and Traders, embracing only those particularly associated with war-time aircraft production.

It was noted by many that Rolls-Royce held aloof from both new institutions, believing them perilously akin to trade unions and likely to frustrate the independence which the great car company preferred.

Most member companies of the SBAC were extremely cautious at this stage of the war in revealing their financial state to shareholders. Thus Vickers stated it had been impossible to complete accounts and would postpone the annual meeting, but as shareholders might be inconvenienced if payment of the year's final dividend was deferred, they felt justified in declaring 1/6d per share, equal to 7½ per cent free of income tax on ordinary share capital, giving 12½ per cent for the year. On the other hand, at the annual general meeting of the Austin Motor Co, Herbert Austin was more forthcoming, and said that sales during the year were nearly £900,000 for goods very different from those previously made, with further large contracts on the books reaching the remarkable total of nearly £2,000,000. 'When the war is finished,' said Mr Austin, 'there will be no difficulty in returning quickly to our regular business, or taking up any line that circumstance may warrant. During the year several large shops have been built and equipped with plant for making shells, aeroplanes, aeroplane engines, and stampings in the most modern and effective manner, and the results show that everything supplied by your company has given thorough satisfaction and upheld our reputation for sound and reliable manufacture.'

The Financial Correspondent of *The Times* commented that the aviation department of Austin's must contribute in no small degree to the financial success of the year's work, particularly as it had 'so capable a designer of aircraft as Mr John Dudley North, formerly of the Grahame-White Company, controlling the destinies of that branch'.

It was C. G. Grey who had induced North, back in 1911, to take up aeronautics as a career. *The Aeroplane* had sponsored a competition to test common-sense knowledge of aircraft, and Grey had picked a 'Mr North' as winner – a name he recollected as the same entrant who won an earlier competition. So he wrote to North and found he was an 18-year-old marine engineering apprentice. An interchange of letters followed from Grey, who was certain that the young man was particularly gifted, and led to North's grandfather allowing the youngster to join Horatio Barber's



Original Farnborough drawing of the R.E.7 dated February 1916. (*Royal Aircraft Establishment.*)

Aeronautical Syndicate. A year passed, and Barber found no market for his unconventional tail-first machine, so decided to liquidate, Claude Grahame-White purchasing the assets via Handley Page, and at the same time engaged young North. Within twelve months this 20-year-old was chief designer, and his G-W Aerobus was the most outstanding weight carrier of its day, setting up a world record of 19 minutes carrying pilot and nine passengers in October 1913. That year Grahame-White exhibited a new military biplane at Olympia which greatly attracted King George V, but though a congratulatory Royal telegram was sent to Grahame-White, it was John North who was the designer.

North had no illusion that aircraft design was the way to get rich quickly. 'We weren't really classed as anything more than entertainers in those days,' he explained. 'We didn't mind because that was the only way to make flying pay. There was no money in selling aeroplanes.' So any aeronautical spectacle such as a parachute drop was used to attract people to Hendon. On the first occasion Guy Newall took a Calthrop Guardian Angel parachute with lines and canopy loosely folded on his knee as he sat on a makeshift seat on the port undercarriage of the Aerobus. Behind him was Frank Goodden to give a hefty push so that he cleared the skid. 'There were sighs of relief from the plane, flown by R. H. Carr, with John North and John Lilywhite as passengers, and cheers from the crowd below when the white mushroom of silk opened above the jumper's head,' ran one of the newspaper stories. Nevertheless the inventor, Ernest Calthrop, a man of flamboyant personality, failed to convince either War Office or Admiralty of its practicality. That is understandable, for the parachute was attached by static line and with its canister weighed 70 lb – the equivalent of machine-gun and ammunition for a Pup. Undaunted, Calthrop pressed his view with the Admiralty that the best way to shoot down Zeppelins was to dive an aeroplane at them, and 300 yards short of target the pilot would jump with his Guardian Angel to safety.

With war conditions, the affairs of the Grahame-White company were proving frustrating for, great airman though he had been, Claude Grahame-White was not easy to work with. But it was the works director with whom John North got at loggerheads, and in the game of forcing resignations of one or the other, North found to his surprise that Grahame-White accepted his – so he left in May 1915. Some months later, John Ledeboer of *Aeronautics* told him that Austins required a manager to supervise production of R.E.7s for which they had just secured an initial order. 'It was the worst design I have ever known,' North told me. He got the job, though only 23, but did not realize five other men had already been sacked from it by the rough and swearing Herbert Austin, of whom everyone seemed afraid. Self-made, Austin had originally been in charge of the Wolseley Sheep Shearing Machine Co, owned by the equally difficult John Siddeley, who presently became interested in car production, which they started with 15 men reporting direct to Herbert Austin. Now he had his own factory at Longbridge, and there John North was handed 100 men of whom many

were crate-makers whom he schooled to become excellent airframe builders once he had sorted out the chaos of sub-contracts.

All the growing firms of the aircraft industry were closely interested in the SBAC's Excess Profits Duty activities. For the House of Commons Finance Bill debate which dealt with adjustment of tax, the Society had briefed Joynson-Hicks to stress that manufacturers of aircraft had no pre-war standard of profits but were recipients of large orders and put the entire profits into their undertaking to increase means of production. After the war those special production facilities would be of little or no value because exceptional demand for aircraft would have ceased; he therefore asked that adjustments under the Munitions Limitation of Profits Rules should be accepted in computing profits. The Chancellor of the Exchequer replied that the Government had gone a long way to meet the Hon Member's argument, but it would not be proper to accept such applications after the authorized maximum profit had been earned. The SBAC realized there was a long fight ahead.

On other matters, Pemberton Billing continued to disturb the complacency with which many MPs seemed to regard the air war. On 2 May he arrogantly asked whether recent criticism in the House on the inefficiency of the B.E.2c when opposed to enemy aircraft had resulted in instructions that no more were to be sent to France. Mr Tennant on behalf of the Government replied that the answer was in the negative. By now Pemberton Billing and his allies had created too critical a situation to be ignored by the Joint Naval and Military Air Committee – with the result that on 7 May the Army Council decided to establish yet another Commission, this time 'to enquire into the administration and command of the Royal Flying Corps with particular reference to the charges made in Parliament and

The R.E.7 was impressively big, and its steel tube crew portion was regarded as an assurance in a crash. It first went into action at the height of the Fokker menace, but proved more useful as a bomber. (*D. F. Woodford.*)

Gun power and field of fire were the immediate lessons of air war. Because the observer of the B.E.2c was under the centre-section many solutions were attempted such as this twin Lewis installation firing aft. (*Imperial War Museum.*)

elsewhere against the officials and officers responsible for that administration and command and to make any recommendation in relation thereto'.

Tennant, the following week, in answer to Mr Hogg, announced the names of the Commission and the appointment of Mr Justice Bailhache, a Judge of the High Court, as chairman. Next day Sir Arthur Markham asked why the six-man committee contained four lawyers. Asquith merely replied that he understood it was desirable that lawyers be nominated. Fiercely Billing insisted it was more desirable to appoint aeronautical experts. To this Asquith answered that two members of the committee were civil engineers of great eminence, and he understood that one of them, Sir Charles Parsons, KCB, was unsurpassed by any engineer, and the other was Charles Bright, who was an expert on telegraph cables and in cable-laying expeditions. An apathetic House took it in silence.

7

That doyen of British aircraft benefactors, Patrick Alexander, who had devoted his fortune to aeronautical science, was in the USA which he liked to visit at least once a year. Interviewed at the Aero Club of America he said: 'There are three great new factors in this war that make it different from any other war ever fought. They are aircraft, wireless telegraphy, and the internal combustion engine. They have compelled such rapid re-adjustment that it is only the young men, abreast of such modern scientific developments, who are in general being thrust into positions of responsibility. We are now equipping aeroplanes with wireless apparatus having a sending radius of 150 miles. I was astonished to be told that on this side your Navy's aeronautical equipment can only provide 10 or 15 miles of wireless communication.

'It is true that England,' he continued, 'has not yet attained her stride in aeronautics. We have 1,000 factories turning out aeroplanes or parts. Women are proving very faithful workers in our aeroplane factories as well

as in other munition plants. What we need – and you need it too – is aeronautical leadership. We need a man or men who can apply aeronautical science in offence as well as in defence. The day is coming for England, as it will for America, when the aeronautical branch will be more important than either the Army or the Navy. Your move to take account of your industrial possibilities and provide for their mobilization is the most important step you have taken towards preparedness. Had we been thus prepared ourselves, the chances are that this war would be over by now.'

Patrick Alexander's views on air policy gained substance following the announcement of the Judicial Committee of Enquiry when the Prime Minister stated he had agreed to form an Air Board with Lord Curzon as President, the other members being Lord Sydenham, Admiral Tudor, Admiral Vaughan-Lee, representing the Admiralty; General Sir David Henderson and General Brancker representing the War Office; and Major John Baird, MP, as secretary. Asquith explained that the Derby Committee had been confined to materials, but the new Board would be much more important, charged with larger questions, including the best method of developing its jurisdiction as a regular department, with a view to forming an Air Ministry.

Churchill opened the debate, saying that the House would have heard announcement of the change with disappointment. The Air Services had long needed guidance by some person of great eminence, versed in public affairs, and with adequate influence in the Cabinet. This they would find in Lord Curzon, but Lord Curzon, without adequate powers, would not succeed in altering the present unsatisfactory state of affairs. In choice of policy the Government had followed no principle except postponement to the last possible moment and then taking the line of least resistance. Vigorously criticizing the government proposal for a Judicial Committee of Enquiry, he insisted that the difficulties from which our air organization suffered arose first from duality of effort and organization and secondly from lack of commanding initiative in design and overriding authority. 'The present proposals,' said he, 'seem a mere attempt to parry demand for an Air Ministry by setting up another Advisory Committee with Lord Curzon at its head instead of Lord Derby. The President of the new Board might advise the Admiralty and the War Office, but they need not take his advice. They would have their own representatives on the Board, and if they dissented from the advice offered by the President, they would have the opportunity of being first to offer their views. Could anyone feel that the proposal was put forward by the Government in sincere belief that it opened the way for this country's aerial supremacy? I cannot think it difficult – though, no doubt, Hon Members would hear of difficulties standing in the way of an Air Ministry – either to devise and bring into operation a unified organization, or to divide on well-marked lines the offices of training and supply from tactical employment of units. I agree that amalgamation of the Services is not possible at a single stroke, but the formation of an Air Department with real responsibility and real powers is

an urgent and indispensable preliminary. The air is free, and the resources of the whole world are at our disposal. Nothing stands in the way of obtaining early air supremacy but ourselves: there is no reason or excuse for failure to obtain what should be the most obvious and practical step towards victorious issue from the increasing dangers of this war.'

While the virtues and demerits of government air policy were being laboriously debated in the House, the British public for the first time heard of a new movement in Ireland called Sinn Fein. There had been warning of unrest the previous month, for newspapers told of an armed raid and of a captured German munitions ship whose attendant U-boat got away after two men landed from her by dinghy, but were found and arrested. With sense of shock, people learned that one was Sir Roger Casement, ex-British Consul in the Congo, who had been in Germany since 1914, plotting an armed rising so that Ireland could break free from British government. Next day Dublin heard the crack of rifles and thud of field guns: rebellion had started. Newspapers of 1 May submerged accounts of the great Verdun battle raging in France with stories of street fighting and house-to-house rifle fire culminating in the rebel-held Dublin Post Office and the Headquarters of Irish Labour Republicanism at Liberty Hall being battered to pieces by gunfire. On 2 May a thousand Irish surrendered, and it was said that their leader, James Connolly, had been killed. Nearly 500 rebel Irishmen, including a certain Eamon De Valera, were put on trial. Stories mounted of executions, even of innocent people. Shame that Britons were fighting each other overcame the first bitter anger against the Irish and their rebellion.

Feeling, expressed by Churchill in the Air Debate, that the Government took the easiest course in everything was reiterated by a leading article in the *Daily Mail* on 20 May, which made famous a new expression the paper tagged on the Prime Minister: 'Mr Asquith, like that other famous exponent of "wait-and-see", King Ethelred the Unready, is never prepared for any contingency. The feeling of the country is that, if Ministers remain much longer where they are, squabbling and wobbling and whittling down every vigorous proposal, this will be a National disaster of the most formidable kind.' But there was no 'wait-and-see' about the Government's new threat of strong measures against printing information about secret sessions. Here was another blow to British liberty.

For the moment incompetence, government scandals, and almost the Irish, were forgotten, for on 1 June huge, jubilant headlines startled the country. At Jutland a great Naval battle had been fought. Here was glorious victory, with expectation that the German Fleet was vanquished for ever. But it was no such thing. There had been hours of action, and two German battleships and two battle cruisers were sunk, and it was reckoned the Germans had lost 18 vessels in all, though how many steamed to safety during the foggy night was not known. Then it transpired that Britain had received an equally tremendous blow by losing six cruisers and eight destroyers. Presently news seeped through that German communiqués

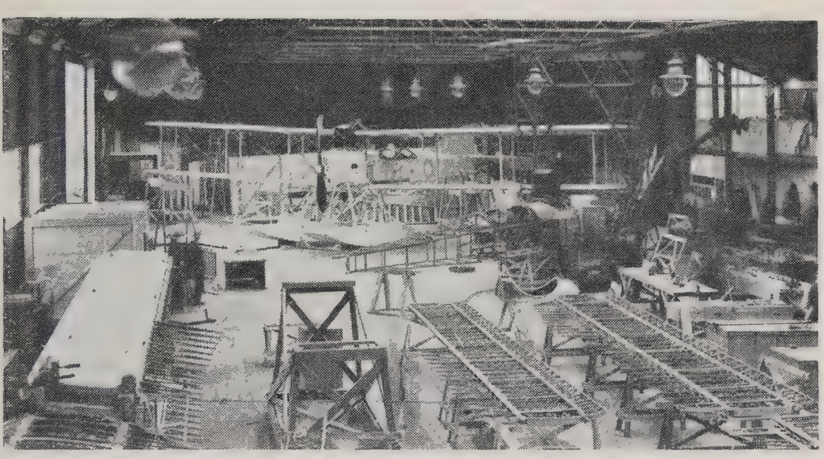
insisted it was their side which had won the victory. There were whispers in Britain of lack of co-ordination between Admiral Jellicoe, Commander-in-Chief of the Fleet, and Admiral Sir David Beatty in command of Battle Cruisers, and even that the Admiralty interfered in the battle by giving conflicting instructions by radio.

The handsome, dashing Beatty told of the first naval use of spotter aircraft: 'By report from *Galatea* at 2.25 p.m. it was evident that the enemy force was considerable, and not merely an isolated unit of light cruisers, so at 2.45 p.m. I ordered *Engadine* (Lieut-Cdr C. G. Robinson) to send up a seaplane and reconnoitre to NNE. This order was carried out very quickly. By 3.8 p.m. a seaplane, with Flt Lieut F. J. Rutland, RN, as pilot and Asst Paymaster G. S. Trewen as observer, was well under way; first reports of the enemy were received in *Engadine* about 3.30 p.m. Owing to clouds it was necessary to fly very low, and to identify four enemy light cruisers the seaplane flew at only 900 ft within 3,000 yd of them, and they opened fire with every gun that would bear. This in no way interfered with the clarity of their reports, and both Flt Lieut Rutland and Asst Paymaster Trewen are to be congratulated on their achievement, which indicates that seaplanes under such circumstances are of distinct value.'

Rutland later commented: 'When *Engadine* came up to the seaplane after alighting, I begged permission to continue, but this was refused. Later the sea became too rough to hoist out planes, but we could have been of great use had we gone on again. It was not that Admiral Jellicoe was not air-minded, but just that he was incapable of adding to his organization any unit which had not been proved 100 per cent efficient to his satisfaction. Thus *Campania*, with her fourteen seaplanes, all equipped with wireless, and a flight deck from which they could take-off, was left behind in port.'

Dealing with next morning's events, Admiral Jellicoe took up the tale: 'The enemy made no sign, and I was reluctantly compelled to the conclusion that the German High Sea Fleet had returned into port, and subsequent events proved this correct. Our position must have been known to the enemy, as at 4 a.m. the Fleet engaged a Zeppelin for about five minutes, during which time she had ample opportunity to note and subsequently report the position and course of the British Fleet.'

The historic seaplane was a Sunbeam-engined Short 184, No. 8359, the fourth built by Westland, and was eventually housed at the Imperial War Museum. 'Rutland of Jutland', as he became known, was a 30-year-old ex-rating sub-mariner, who on the eve of Jutland earned the gold Albert Medal, awarded only for 'cases of extreme and heroic daring', by diving to the rescue between *Engadine* hauled close alongside *Warrior*, where a wounded sailor had fallen in. A contemporary described him as: 'Very gallant; very efficient, brisk, and entirely self-centred; a TT and non-smoker; always engrossed in his own affairs and showed no interest in his very young pilots, nor joined in any social occasions in the Mess – just came in for meals.' Although unpopular there is no doubt that he was a great and determined man frustrated by his background, but none could foresee



The first Westland-built Short 184 is erected at Yeovil amid partly-finished wings and fuselages in sequence construction rather than series production. Completed aircraft were taken to Hamble for flight testing by Ronald Kemp of Shorts.

that in later years he would be imprisoned as a suspected spy of the Japanese.

On 6 June angry contention over Ireland and heart-searching over Jutland vanished before appalling news that Lord Kitchener – that great man on whom the Britons believed their destiny rested – had been drowned when his ship, the *Hampshire*, was torpedoed just off the Orkneys at the beginning of a voyage to Russia where he intended to stiffen Eastern resistance against the Germans. To many it seemed the greatest of all great disasters which had struck at Britain, and thought of entrusting the future to weaker hands seemed the abandonment of hope. It kindled bitter criticism against the government whom everyone believed had sent Kitchener on this visit merely to get rid of him while they muddled on.

8

At the beginning of June, Harry Hawker tested the Clerget-engined Sopwith Triplane. Within three minutes of take-off it was obvious another success had been scored, for he looped it. A few days later the Triplane was fitted with an external Vickers machine-gun in front of the cockpit, and still in its clear dope finish, but now numbered N.500, was delivered to the RN Air Station at Chingford. In mid-June it was flown to France for Service trials with Naval 'A' Fighting Squadron at Furnes, and no sooner had it been refuelled than it was sent to intercept a reported hostile aeroplane. The 'Tripehound' was an immediate success, with handling qualities akin to the delightful Pup, but its greater power and higher aspect ratio wings gave it the vital advantage of slightly better climb and higher ceiling, as well as 5 mph greater speed.

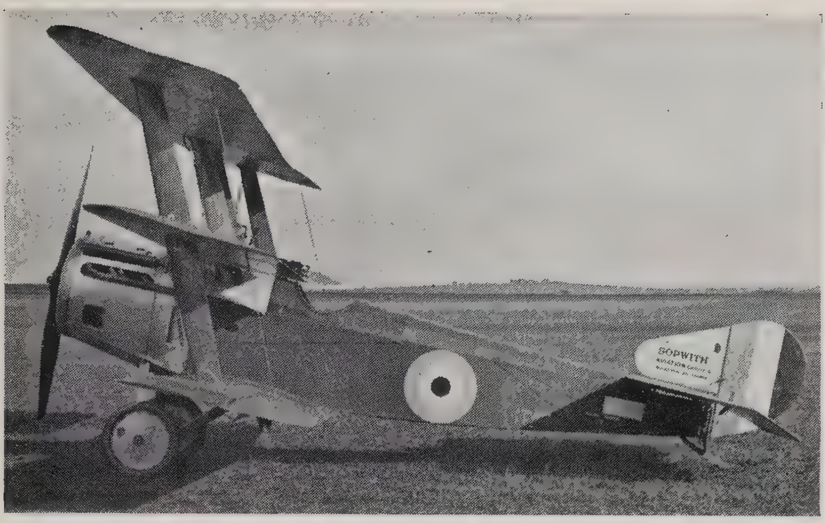
It was no great drawback to Sopwith that neither of the water-cooled engined triplanes was in immediate demand. Their shops were crammed

with 1½-Strutters, Pups and rotary Triplanes under construction for Admiralty and RFC, and another section was still devoted to the Baby seaplane, known as the Schneider to the Navy, which was the ancestor of all their fighter designs. 'It was the machine for a lover of solitude and independence and the wandering kind of life,' wrote the chronicler of the Great Yarmouth Air Station.* 'The Schneider was a sort of detective, exposing all mysteries, such as whales mistaken for submarines, streaks of oil, and rescuing colleagues in difficulty. Any wild rumour, and out went the Schneider to investigate! They were the police force of the Yarmouth Patrol.' Successful though they were at light weight, the tasks of war inevitably led to overloading. As a result complete redesign was undertaken by Fairey at Hayes, using Sopwith-built Baby No. 8134 as a mock-up for fitment of longer span wings incorporating his innovation of variable camber using deflectable trailing-edge flaps, for which he was granted Patent 135,520 and others.

The clear-doped prototype Sopwith triplane N.500 ordered by the Admiralty goes to Chingford for handling flights before proceeding to France in June 1916 for operational trials. (*R. E. Nicoll.*)

A further version with modified wings and 130 hp Clerget was being built by the Blackburn company, who were sub-contractors for the standard Schneider Baby. Assembly was at their new factory on the Yorkshire shore of the mile-wide Humber near the ferry running to the oft invisible Lincolnshire side. Legend had it that little Mark Swann, one of the early employees to whom Blackburn remained loyally friendly, had been sent searching for

* *The story of a North Sea Air Station* by C. F. Snowden Gamble (reissued by Neville Spearman).

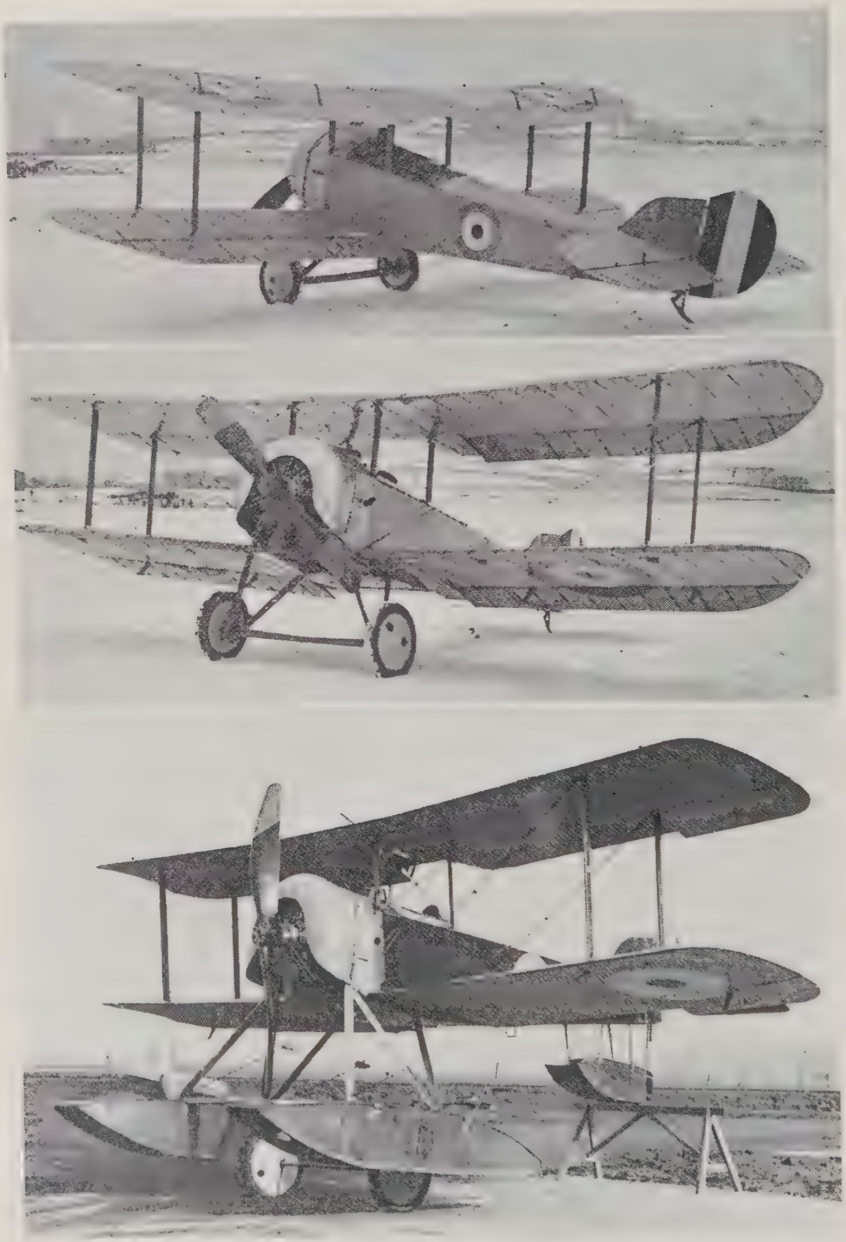


The Hispano-Suiza powered Sopwith triplane was not as clean as it seems, for the middle wing was on top of the fuselage, giving a decreasing wedge for the air flow, resulting in turbulence which caused the tailplane to break off of the more powerful second prototype, N.510. (*H. Busteed.*)

sites suitable to launch their twin-fuselage T.B. seaplane, but as a man dedicated to good ale he spent the day at the only place on the river where the local pub was close to the water's edge. Eventually enquiring the name he found it was Brough, and delightedly recommended its flat, silent fields.

The Royal Aircraft Factory was no less busy than the Trade. The first B.E.2es were emerging from production lines, characterized by their shortened lower wing, stiffened spars, and long top wing overhangs Rafwire braced, using a triangular pylon above the single bay of interplane struts each side. Test flights showed that this new version flew very steadily, but required constant pressure with the left foot to keep it straight. Nobody

Front view of the Hispano-Suiza powered Sopwith triplane. (*H. Busteed.*)



Sopwith Baby No. 8134 (top and centre) tested as a landplane with experimental wings designed by Fairey. They incorporated patent camber-changing gear full span ailerons capable of simultaneous use as lift flaps and enabled two 65 lb bombs to be lifted more easily than by the standard aircraft. The Blackburn-built Baby (bottom) had a Lewis gun mounted obliquely in the centre section aperture. (*H. Busteed Photos.*)

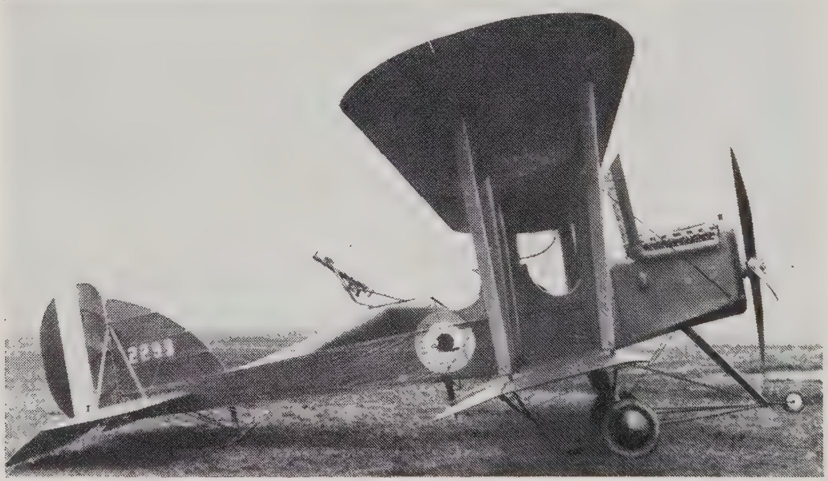
had thought of compensating springs or trimmers. Fairly strong lateral pressure was required to bank into a turn, with practically no rudder to right, but a strong push for the left. The 2e droned happily along, allegedly with a bare margin of 25 mph between top speed and the gentle stall. Despite early apprehension that the overhangs would fall off under violent manoeuvring, it proved rugged and never let the pilot down, even proving a little more agile than the 2c in dodging Archie or enemy aircraft. Instrumentation, like all its contemporaries, was of the barest, but it had a tail-plane incidence gear. The first squadron equipped was No. 34, which

Unconventional arrivals were frequent throughout the war. Time and again light wing loading limited the damage, as shown by this B.E.2e which hit a roof. (*D. F. Woodford.*)

arrived in France on 15 July. Meanwhile another hasty adaptation had been made by converting the B.E.2c into a single-seat fighter powered with the 150 hp RAF 4a engine in desperate attempt to obtain more speed. The first reached France towards the end of June, but those who flew it were soon disillusioned of its ability as a fighter, for it retained the excessive stability characteristics of the type which, although suitable for a gentle-manly tourer, was fatal operationally through lack of manoeuvrability.

The chief engineer at Farnborough, Fred Green, now ranking as Captain, not only had the S.E.5 to consider, but was supervising a team led by J. Lloyd and W. H. Barling, which was completing the R.E.8 as a replacement for the big R.E.7 and able to defend itself. It was the same specification in which Frank Barnwell was interested, and as a first step an R.E.7 had been flown with a rear-gunner cockpit behind the pilot, still retaining the front observer, but it was too cumbersome and complex for the purpose. By the usual process of trial and error a smaller fuselage was modelled on the R.E.7, with the top longeron sloping upward to the tail, giving an

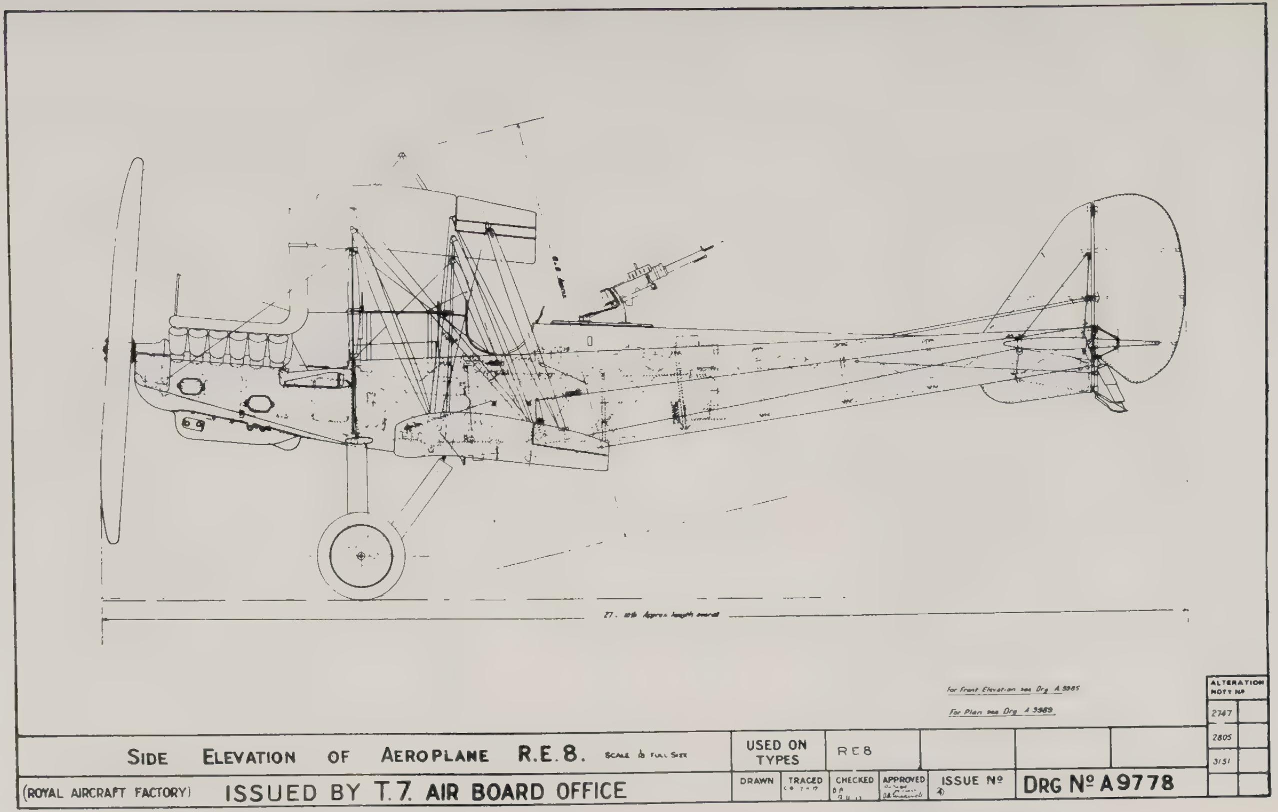
oddly elegant yet broken-backed appearance. Span was reduced from 57 ft to 42 ft 7 in, retaining the long top wing configuration, but with a single-bay structure having overhang loads braced similarly to the 2e. Appropriate C.G. balance and enhanced view were secured by using considerable stagger, and the wings had the customary marked dihedral favoured by the Factory. A 150 hp RAF 4a engine was mounted with upward thrust line which slightly aided take-off but primarily was intended to give a natural glide on throttling. The Folland touch showed in the rudder, with sprung tailskid set in a cut-away at the bottom of the rudder and pivoted from a lower fin. Aerodynamically the design was the result of considerable wind-tunnel work to ensure adequate stability and good control response, but although the original design showed a big fin, the one fitted was narrower and seemed too small.



The R.E.7 with a 190 hp Rolls-Royce engine was tried with an additional cockpit carrying a Nieuport-type rotating gun ring, and was used by No. 20 Squadron from early autumn 1916 for some four months. (*Imperial War Museum.*)

In June the first of the R.E.8s was ready, and very handsome it looked. Initial flights in the evening of 17 June made by Capt Frank Goodden indicated they had a winner, and a fortnight later the second prototype was sent to France for operational trials. Large orders had been placed even before the machine flew, and it was expected that the first squadrons would be equipped with production machines in the autumn, of which the opening 50 would be built by the Royal Aircraft Factory.

Meanwhile Goodden and the Farnborough aerodynamicists were concerned with squadron reports that the F.E.8 pusher fighter was causing many casualties through spinning accidents. It was the same panic which had occurred with the D.H.2, resulting in its unjust label of 'spinning incinerator'. All aircraft still had only a relatively small speed range between stall and cruise, and few pilots understood that when the control



Original Factory drawing of the final production R.E.8. (*Royal Aircraft Establishment.*)

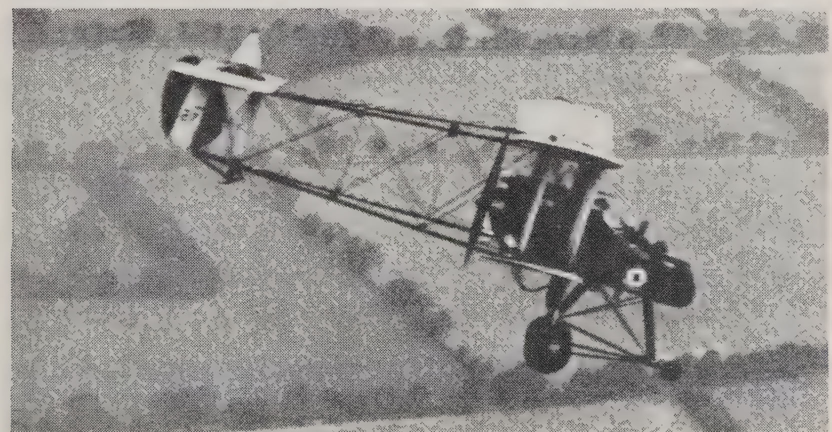
The F.E.8 prototype was completed in October 1915. The first F.E.8 Squadron did not reach the Western Front until August 1916. (*Imperial War Museum.*)

column was pulled back to hold a steep turn it increased the effective wing loading, producing a stall at earlier speed. As a result many flicked into a spin, but in 1916 few understood the nature of this phenomenon nor how to move controls for recovery. Like Hawker and Raynham, Frank Goodden was an exception and deliberately initiated spins, pushing the control column to increase speed for recovery, and applied rudder as though to steer away from the turn. Three times he spun an F.E.8 in each direction from 3,500 ft, regaining control with no hesitation, and thus finally established the standard method of recovery. From that point the machines were accepted without qualm, and although the greater span of the F.E.8 compared with the D.H.2 made lateral response somewhat slower, pilots found that its modest stability offered a steady gun platform, though the mere 94 mph made it a fairly easy target if German aircraft had the advantage of diving height.

All through June there had been rumours on the Front that a big push was imminent. More and more new battalions recruited as Kitchener's Army were being brought into the arena, conditioning them to the trenches, the sporadic gunfire, and occasional casualties. Every clump of bushes and trees giving semblance of cover sheltered netted guns hidden from the few hostile aeroplanes that sometimes appeared high in the sky like midges, followed by white puffs of shrapnel smoke as they attempted a photographic reconnaissance. Many formations of F.E.2bs and the distinctively smaller D.H.2s constantly headed eastward to prevent such flights, or shoot down German artillery-spotting sausage balloons, denoted by remote but distinctive black puffs where grouped Archies defended them. But it still seemed a country of peace, where birds sang in orchards, copses were bright with leaves, and wild flowers starred the rolling downland. Only the scar of distant trenches and the smoke-puffs revealed that this was war.

Dawn on the first day of July found more than a quarter million of Britain's amateur soldiers, together with a sprinkling of Old Contemptibles, waiting in the trenches of a 12-mile front-line cut into the chalk of Picardy around the Somme – and away on the right the French were ready in another eight miles of trenches. Indeed Field Marshal Sir Douglas Haig had planned to attack at dawn, but was overruled by Marshal Joffre who believed that full daylight was essential for effective fire control of his special field guns. Their combined plan was to smash and overwhelm the German infantry with annihilating bombardment, and thus open the way to a general advance into enemy territory. . . . In silence everything waited – until at 6.30 all hell broke loose with the greatest allied bombardment of all the war to date, shells by the hundred thousand pouring on the enemy trenches in a great roll of crashing thunder and detonations that shook the land. Neither those in command, nor the soldiers crouching white and tense, ready with bayonets for the charge, had any inkling that the Germans had dug themselves 30 ft deep in the chalk and were safe behind the great swirling cloud of smoke and dust of the hour-long bombardment.

Twenty-seven RFC squadrons were ready for their share, some already airborne. Of the 430 available aeroplanes, the majority were B.E.2cs allocated for 'Corps Wing' short-distance reconnaissance, photography, and artillery co-operation. Benefiting by French experience of the first all-out German attack at Verdun towards the end of February, where even obsolete Farmans and Caudrons successfully directed accurate gunfire, the RFC had developed an effective communication system using variable-pitch Morse to avoid jamming, with a two-letter call sign denoting map reference, and now aircraft observers could direct every gun within range to fire on any chosen target. An 'Army Wing' had the onerous task of



Air-to-air photographs during the Great War were rare. Here an F.E.2b flies above the small fields of England into which only machines with light wing loading could make safe landings. (*Flight Photo.*)

long-distance reconnaissance, air fighting, and photography, sometimes using B.E.s, but delegating most of the work to F.E.2bs which also were used for ground-strafing. Already this big pusher had valiantly proved an effective fighter, and had done much to eliminate the success of the Fokker. Even the great Max Immelmann, who was so successful in using the earliest gun interrupter gear, had been shot down in the late evening of 18 June by Corpl Waller, nose gunner of an F.E. flown by 2nd Lieut G. R. McCubbin. But performance with the 120 hp Beardmore was no better than the smaller, rotary-engined Vickers F.B.5 Gunbus; however its 200 lb greater load capacity and more reliable engine were not to be discounted, and consequently the last Vickers Squadron, No. 11, had only four F.B.5s on its strength and the type was down-graded to trainer. As the slow and stately speed of the F.E.2b remained a big drawback, the Royal Aircraft Factory was repowering it with the 160 hp Beardmore now in production, and intended to fit the 250 hp Rolls-Royce as soon as some could be spared.

To support offensive patrols, Numbers 1, 3, and 60 Squadrons were equipped with Morane Bullets. By the summer of 1916 Trenchard had demanded that all single-seat Scouts attached to squadrons of other types be withdrawn and concentrated at Army Wings. Even so the RFC had not enough fighters to be certain of air superiority, which led Trenchard, in preparation for the Somme offensive, to request the Admiralty for assistance. Realizing the imperative nature of this requirement they transferred the 1½-Strutters with which No. 3 Wing RNAS had just been equipped from the initial contract for 50 from Sopwith – and a similar order placed by Sefton Brancker with Ruston, Proctor & Co towards the end of February led to machines being flown to France as they became available, so that No. 70 Squadron had two flights by 1 July.

Despite adequate air support and the vast barrage of gunfire, that first day of the Somme was a disaster. The troops had been told nothing would remain of German defences at zero hour. Abruptly shelling had ceased and became overwhelming silence. British and French stormed up the wooden ladders from their trenches and over the chalk-filled sandbags into the cratered and pitted and torn No-man's land separating them from the German barbed-wire. Instantly the enemy parapets spurted devastating gunfire. Safe in their deep dug-outs during the shelling, the Germans had emerged and were waiting and ready. Everywhere the Allied troops were mown down in swathes. Only a few units from two or three of the entire thirteen divisions managed to reach their objectives. By nightfall there were nearly 60,000 British casualties, and everyone knew that the attempt had utterly failed. But at least the Royal Flying Corps was able to hold its own, as the Germans later confirmed. 'Innumerable airmen with the latest machines crossed our fire and entered the rear of the German combat areas,' their official history stated. 'They dropped bombs on troop shelters, machine-gunned our batteries and marching columns, and photographed every detail of the German defensive system.' Mankind was witnessing the first great organized employment of aerial squadrons.

CHAPTER IV
THE GREAT PLOT
1916 (*cont.*)

'Comes a damned summons to attend the Committee of Miscarriages to-day, which makes me mad, that I by my place become the hackney of this office, in perpetual trouble and vexation, that need it least.'

S. Pepys (1668)

1

THE RFC enquiry was in full swing, but witnesses were only turning over old ground, comparing products of private firms with those of the national Factory. Joynson-Hicks stoked the flames with information that 4,223 men were employed there, earning a staggering weekly pay total of £9,438, and that Mervyn O'Gorman's pay had increased from £1,500 annually for part-time services to an unprecedented £3,000 full time, while his four senior officers received £630, £550, £550 and £450 – but apart from O'Gorman's well-merited salary, this was little better than private industry offered. Typically of the enquiry saboteurs, C. G. Grey stated 'on the authority of one of the most successful aeroplane constructors' that whereas an experienced firm could build one of their own designs in six to eight weeks, the B.E.2c took nearly 12 weeks: then again, six months had been wasted over the R.E.5 and R.E.7 because they were never liked by the flying officers and were impossible to land in a small area – so their ultimate fate was the scrap-heap.

General Sir David Henderson, knowing the whole story of the great range of outstanding aeroplanes currently being developed, listened coolly to the witnesses – particularly as manufacturers, with one exception, refused to give evidence; though it was alleged they feared being stranded without orders if they spoke. He said several charges had been made against him, of which one 'was that I was head of a group determined to obtain control of the entire air services, naval and military. I wish to state that I undertook charge of the Royal Flying Corps most unwillingly, and not until it was proved my duty to subordinate personal feelings to that of public service did I undertake my present position. In order to do this I had to relinquish the office of Director of Military Training at Headquarters Staff, which I much preferred to hold.'

Lieut-Col Mervyn O'Gorman (left) in October 1915; he was the great genius of British technical development, Lieut-General Sir David Henderson, who learnt to fly in 1911, was instrumental in forming the RFC where his sympathetic and well disciplined mind made him ideal in shaping the new Service. (*Flight Photos*.)

Emphatically denying allegation that the Factory was simultaneously competitor and judge, so that selection of aircraft would be entirely in its hands, Sir David declared that since early 1912 the Factory had not even been consulted in such matters: in fact he stopped construction of a certain Royal Aircraft Factory machine after 4½ months, because the Sopwith and other good machines could be obtained from private makers. He defended the B.E.2c as the only aeroplane sufficiently proved before the war to justify ordering in quantity, and added that the D.H. pusher Scout had been undertaken at his request – as indeed had the S.E.5 and R.E.8.

When Dr Glazebrook was asked whether the B.E.2c was an efficient and satisfactory machine he replied: 'Thoroughly,' and explained that to combine all the qualities required in one design was not easy, so it was a compromise for its power. Members of the Commission appeared unaware that all Factory designs were the result of careful scientific study, or that evolution of the B.E.2c had depended on experimental work at the NPL. Professor J. E. Petavel, Head of Engineering at Manchester University and a Member of the Advisory Committee for Aeronautics, endorsively stated that the B.E.2c was more easily controlled than many others, and had particular advantages. Others gave similar evidence in flogging the dead horse, for the Department of Military Aeronautics had long regarded the machine as obsolete.

In reply to further questions, O'Gorman denied absolutely that any design of any sort at any time had ever been copied by the Royal Aircraft Factory from private firms. As to Lord Montague's taunt that the Factory, instead of encouraging British manufacturers to build engines, had tried to keep the monopoly in their own hands, O'Gorman insisted that nothing but distortion of attempts to help people could be made to look like that, but incautiously added: 'Engines have been mothered by the Factory.' The chairman quickly commented that critics put an S before the word

mothered. Said O'Gorman: 'I have not built more than four experimental engines at the Factory, and there is no kind of monopoly as regards construction. As to aeroplanes, we produced something less than two per cent of the total in this country. Had we attempted a monopoly either of engines or aircraft we should have been cutting our own throats because we could not produce anything like the number required.'

When the chairman asked why, if so many were employed there, had only four experimental engines and 77 aeroplanes been produced, he left O'Gorman in the happy position of pointing out that the Factory did all the jobbing work for the Flying Corps, 'making every kind of oddment that anybody at any time could not make or get.' Because war wastage was so great, they made spares for machines at the Front, but it had to be all by hand and not machinery. The name 'Factory' was misleading; it was really a full-scale laboratory. Designers and engineers from every aircraft company had made countless visits and knew there was no competition, for the function of the Factory was practical instructional and development work, together with much experimental investigation, and the results were at the disposal of manufacturers.

At this, the Commission adjourned *sine die* with a view to issuing its report. There were no congratulations for the vital training O'Gorman had given to a vast body of men in essential technics not only of aircraft and engine construction but of electrical gear, cameras, oxygen equipment, armament, and research into every material necessary for construction of aeroplanes, engines, airships, and kite balloons.

2

While the RFC Enquiry had been grinding on, little was heard of the Royal Aircraft Factory investigation. The Battle of the Somme had been raging nearly three weeks when at last the aircraft industry received Parliamentary Paper No. Cd.8191 containing the Report of the Committee, signed by Sir Richard Burbidge, The Hon Sir Charles A. Parsons, KCB, and nominally by Sir Frederick Donaldson who had lost his life when HMS *Hampshire* was sunk. Although dated 12 May, publication had been deferred while the Army Council considered the Report, and it was now issued with an overruling statement from the Air Board dated 19 July, signed by Lord Curzon of Kedleston as Chairman.

The Committee was largely placatory towards Farnborough, but in offering a number of reorganizational recommendations, specifically proposed a Board of Management comprising an Administrational Director, a Superintendent of Design, a Superintendent of Manufacture, and a Military Adviser. The Director should have commercial and scientific engineering qualifications, though it was not considered essential to have intimate knowledge of aviation. It was suggested that it would assist the organization if a civilian was appointed as Controller of Aircraft Supplies, with headquarters in London, to act as intermediary between contractors and Factory.

The Air Board's rejoinder baldly stated: 'As regards the measures which should be taken to improve the administration of the Factory, the Air Board have come to the following conclusions, which are in conformity with the recommendations of Sir David Henderson, and with which they are hopeful the Army Council will concur: –

'They do not agree that the Factory should be placed under a Board of Management. Such an arrangement, however suitable for a private factory, would be ill-adapted to exigencies of military organization. The Factory should be under direction of a single Superintendent, possessing special qualifications of business experience and administrative capacity. In this connection Colonel O'Gorman has rendered eminent public service in design and construction of aircraft, but these abilities can best be employed in the future in the capacity of Consulting Engineer to the Director-General of Military Aeronautics at the War Office.

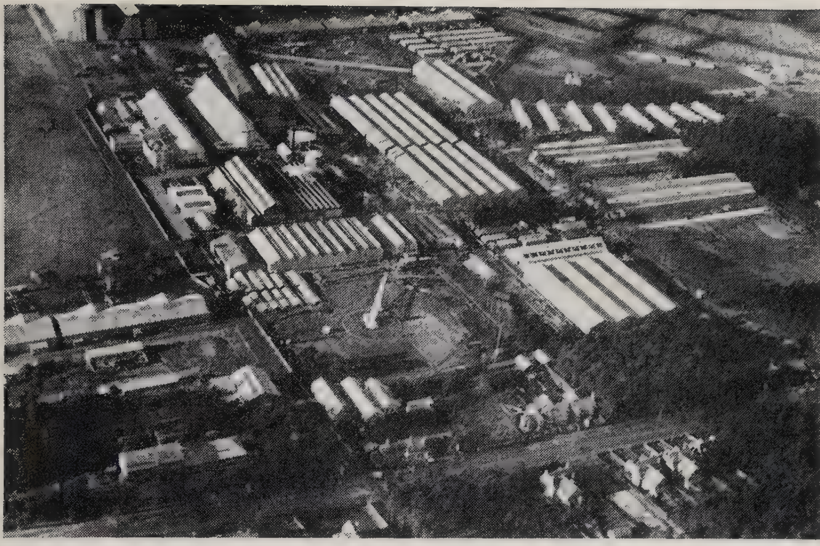
'Under the proposed new Superintendent, there should be a head of Design and a head of Production. The Air Board do not share the view that a Military Adviser with distinctive executive duties should be attached to the Factory as this could be better discharged by the Director of Aircraft Equipment at the War Office. The Board agree that direct communication between Factory and contractors should be a minimum, and do not think it necessary to create a post of Controller of Aircraft Supplies as intermediary between Factory and contractors as this can be adequately discharged by the Department of Military Aeronautics.

'The proposal that capacity of the Factory should be directed to increasing the current manufacture of aeroplanes and engines raises a difficult question. The larger the proportion of production to experiment, the more creditable will the balance-sheet of the Factory appear. On the other hand, not only does the present production of the Factory, limited as it is, arouse suspicion in the minds of private manufacturers, but increased production of engines could only be obtained if new shops were built. There is no room for extension, and if there were, no output could be obtained in less than 10 months. The object should be increased output of aeroplanes by improving organization of the existing staff. No reduction should be made in the amount of experiment conducted at the Factory. On the contrary, this is the aspect to emphasize by every possible means.

'The Board have had under special consideration the question of increasing the output of engines by the Trade, but the limiting factor is not financial assistance, but the lack of skilled mechanics.

'Any measures of reorganization of the Royal Aircraft Factory should be adopted with concurrence of the Air Board.'

By the time Curzon signed this statement, Mervyn O'Gorman had quietly disappeared from the scene, for his contract had expired and not been renewed. Undoubtedly he had been the greatest of those in Great Britain engaged in this new science of aeronautics – judging shrewdly the line of technological advance, and establishing research on a scale which had led the whole world. Farren, who at that time held the rank of Captain RFC,



View of the Royal Aircraft Factory which in a year had tremendously expanded from the strip formed by the rectangle between the airship sheds (top) and the whirling arm (centre). (*Royal Aircraft Establishment.*)

and was in charge of Aero-Flight experiments and their correlation with wind-tunnel work, recollected: 'I remember being called to O'Gorman's office and asked to sit down at his desk opposite him while he re-wrote one of my reports under my eyes. At first I felt indignant. I believed my meaning was clear, and facts beyond dispute, and it took me some time to realise that this was not what he was driving at. He wanted to put the matter a bit differently, with the idea either of warning off criticism or securing support. I gradually realised that he thought a lot about such problems. It seemed he thought he was under attack. I knew nothing of the criticisms levelled at the Factory, but I soon learned.

'It is difficult not to draw the conclusion that O'Gorman was the victim of the success of the instrument he had created. As an experimental establishment, Farnborough might have been accepted by a growing industry as a valuable asset; but if instead of merely flying to extend knowledge and power over the air, it continued to design and build prototypes intended either to meet or inspire what could be called "Air Staff Requirements", it was clearly dangerous.

'It may well be that O'Gorman had no further direct influence on the progress of British Aviation, but it is certain that what he did up to 1916 created a tradition which gave inspiration to those who adopted it and have recognized it ever since. Though not in the strict sense of the scientist or engineer, he understood that kind of human being, and their interesting and often strange points of view – indeed he seemed to understand all those who had the privilege of being known by him. He was a great man. Only those who worked with him know how very great.'

Indeed, all O'Gorman's staff remembered him in similar terms, and their very names still emphasize his enormous competence in choosing the right men for the unfolding and novel tasks that were the theme of aeronautical development. Among them was Sir Geoffrey de Havilland, who commented: 'O'Gorman never suffered the soldiers gladly, and could not see eye to eye with General Henderson who was his chief at the War Office. I know that it was this lack of understanding and harmony which eventually led to O'G leaving Farnborough.' And the man who was O'Gorman's chief engineer and de Havilland's earlier boss said: 'There is one thing I think must have cheered him not a little. After the end of his term, Headquarters decided that a good civil servant and organizer need not be qualified as an aeronautical expert. The Factory henceforth was ruled for some years by men who did what they were told without question. This went on until World War II, when at last a man who had spent his life in the service of aviation as a practical designer, pilot, and scientist, was appointed Director of the RAE.* O'G no doubt remembered that this man, William Farren, had been successor in 1915 to Edward Busk, carrying on his work of aerodynamic experiments in flight. Colonel Mervyn O'Gorman by his vision, wisdom and the sheer force of personality, did as much as any man to get British Aviation away to a good start. He was perhaps a bad civil servant, but he certainly was a great pioneer. He had the affection of all who worked for him. Maybe the satisfaction of the job well done was a greater reward than public recognition.'

I too remember him on a November evening in 1952, when he was one of a gathering of the friends of Roderic and Geoffrey Hill at a party commemorating their gliding experiences 40 years earlier. All survivors of O'Gorman's Farnborough days were there, and as Laurence Pritchard recorded: 'The world rolled back for him, and his energy that night, his enthusiasm, were those of 1912, when he was in his 40th year – the same energy still, although he was then turned 80.'

Not long after publication of the Burbidge Committee findings, the Advisory Committee for Aeronautics issued its 1915–16 report – but symptomatic of war, instead of the usual portly illustrated volume, it was a mere pamphlet of a dozen pages because most of the year's work concerned secret detail improvement to military and naval aircraft. Yet so much was being undertaken that two new wind-tunnels had been added to the three previously available, and the customary routine testing of new wing-sections had continued with even greater emphasis. As resistance of elliptical Rafwires had been remeasured and found little greater than streamlined forms and easier to make, it was recommended they should be standardized – but universal joints at the end fittings were advisable as a precaution against fatigue due to vibration. General factors of safety had also been revised, but although a minimum of six was provisionally adopted it was realized this must be substantially reduced in some cases to secure a light-enough machine to give the requisite speed and climb. 'This decrease,

*The Royal Aircraft Factory became the Royal Aircraft Establishment in June 1918.

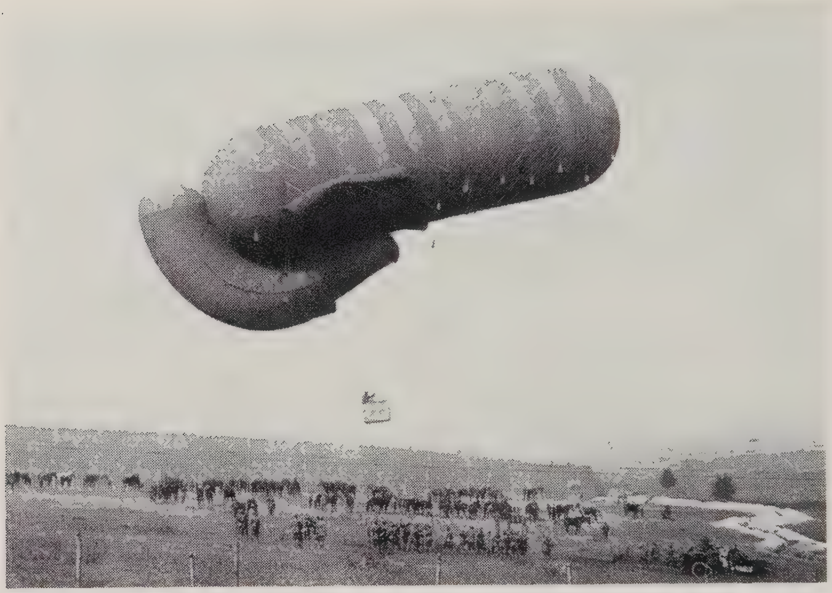
of course,' continued the Report, 'makes it imperative to diminish as far as practical "the factor of ignorance" though much has been done during the year to improve methods of calculation.' Despite paucity of information it was clear that an even wider field of aerodynamic, structural, and material investigations had been covered than previously.

Nevertheless it gave C. G. Grey derisive opportunity in *The Aeroplane*, for he described the document as 'the annual advertising pamphlet belauding the goods alleged to have been delivered by that entertaining agglomeration comprising the Royal Aircraft Factory, the National Physical Laboratory, and the Government Advisory Committee for Aeronautics – more conveniently to be known hereinafter in the aggregate as the Aeronautical Mutual Admiration Society'.

3

Throughout the summer Frederick Handley Page had been nearing success with his great O/100 bomber. Yet another prototype had been completed, No. 1457, with redesigned fuselage to give greater stiffness by using larger-section longerons and struts, made hollow to avoid increasing the weight. Fittings were redesigned so that the pull at each strut was exactly in the centre to give no further twisting or bending tendency. Instead of cables, swaged rods were used. The result was an exceedingly rigid structure. Nevertheless, early flights were disappointing. Flown on 25 and 26 June, on reaching 75 knots tail vibration occurred just as badly as with the original. Both Admiralty and the firm's technicians were convinced that fuselage weakness could no longer be the culprit, and on the advice of F. W. Lanchester, long renowned for his intuitive grasp of aerodynamics, decided as a last resort to test for synchronous periods between engines and fuselage. They mounted the machine on trestles under the centre-section bay, leaving the tail unsupported. Both engines were then run, using reduced-diameter propellers to attain the same maximum rpm as those of normal level flight. To everyone's surprise, all attempts to make the tailplane vibrate proved impossible, but they had failed to understand the difference between static and dynamic support. However, Handley Page was convinced that the overhung balance of the elevators must be the trouble and instructed these portions to be removed. The sceptics were confounded – for on the next trial flight by Clifford Prodger the result was entirely satisfactory.

In common with most British aircraft the O/100 elevators were independently hinged to the tailplane. H. P. had spotted that each seemed to move in opposite directions during tail vibrations, and realized that the long control cables gave sufficient play for this to happen, with the result that in the air the complete biplane tail oscillated 10 inches up and down, although a man sitting on the tailplane tip could only deflect it 1 inch. George Volkert advanced the explanation that: 'At some definite forward speed a small vibration is started, possibly by over-balanced elevators, and the swing of the tailplane throws up the elevator on the high side as soon as



An RFC Drachen-type kite balloon ready to ascend at the Minden Post supporting trenches, looking towards the battle-area of Fricourt. Note the many teams of limber-horses. (*Imperial War Museum.*)

the tail reaches the top of its swing. The result is to reverse the air pressure on it, thus causing a large force to push that side of the tail down again. As soon as the tail reaches the bottom of its travel, the momentum of the elevator causes it to travel on and again reverse the air load on the tail. In this way the vibration goes on increasing in magnitude until a fracture may eventually occur.' As a precaution it was decided that future machines would have one long continuous elevator for the top tail surface, and the lower elevators would be so wired that differential action could not occur.

At last the way was gloriously open for full production at Cricklewood. A great wave of optimism ran through the works. For the first time Britain had a real weapon of offence, and so satisfactory was the lifting ability that the bomb load was further increased to 16, and an overload of 370 gal of fuel carried instead of the original 290.

'As there is no provision for tracking the chassis wheels, the machine should if possible be taken off the ground head to wind,' cautiously warned the Pilot's Handling Notes. 'On soft or muddy ground it is necessary to hold the nose up when starting, but after gaining speed it is generally necessary to keep the nose down, or the machine will endeavour to leave the ground at too low a speed. The flying presents no difficulty; control movements should be small and deliberate. It should be noted that the unusual position of the pilot, some 12 ft ahead of the C.G., has a tendency to exaggerate all movements of the machine. Turning is carried out in a perfectly normal manner; it is not necessary to alter the engine revolutions

on either side, but this could be done if it is desired.' Here at last was the bomber to smash the enemy's munitions at their source, and production deliveries, scheduled for September, were eagerly awaited by the RNAS.

With August the long struggle of Verdun had worn itself out, but the great battle of the Somme was still sweeping forward. Long lists of casualties, issued in daily batches of ten thousand, gave name after name of master and man, labourer and farmhand, clerk and shop-keeper, schoolboy and undergraduate, with a mounting roll grimly emphasizing that the battle-ground was a graveyard of lost hope whether for Allies or Germans. For the first time pictures were released showing the devastated countryside in a vast earthy area of shell holes and craters, trees and copses obliterated, and whole towns and villages no more than scattered bricks and remnant walls. It was utter annihilation such as the world had never seen before.

But in the British Isles the sun shone on holiday crowds, marching soldiers, and great green-painted WD lorries rumbling on tyres of solid rubber. Naval uniforms and civilian clothes mingled on the trackway around the hangars of Hendon aerodrome where most aeroplanes wore the blue, white, and red insignia of the British Services; but the racing pylons stood unchanged, and many an unadorned Boxkite was in use for instruction – so the scene seemed little changed from peace-time days.

In the height of summer the Aircraft Manufacturing Company finished the first of Geoffrey de Havilland's new tractor reconnaissance-bombers – the D.H.4, powered not by the envisaged 160 hp Beardmore, but with a new type of six-cylinder inline engine from the same stable. It was designed by a tall and irresistible young man named Frank Bernard Halford, described as: 'Of dynamic enterprise, warm in heart, extraordinarily magnetic, gay in adventure with the *panache* of a D'Artagnan, an echo of the Robin Hood of his beloved county of Nottingham.' After attending the same school as Rex Pierson, he briefly experienced Nottingham University,

The prototype D.H.4 had a stepped-up nose cowling to accommodate the tall vertical BHP engine, and there was a clear view panel in the centre-section in hope of improving the observer's view, which had all the deficiencies of a B.E. (*de Havilland Aircraft.*)

As production of the BHP was not yet in sight, the second D.H.4 prototype had a 250 hp Rolls-Royce, but the earliest production machines fitted with this engine did not reach France until March 1917. (*Imperial War Museum.*)

but not finding it congenial, learned to fly with British and Colonial at Brooklands in 1913 and became a flying instructor. Next year, aged 20, he joined the new AID in April at 50s for a 48-hour week, and found outlet for his burning interest in powerplants under Capt Bagnall-Wild, at that time Inspector of Engines. On outbreak of war Halford enlisted in the RFC as a foreman artificer, and on return to England was promoted a 2nd Lieut in January 1915. Reallocated to the AID as Assistant Inspector of Engines, he was stationed at Dumfries with the Arrol-Johnston Car Co who were building the Austro-Daimler six-cylinder vertical on behalf of the licensees, Sir William Beardmore & Co Ltd. In bluff C. T. Pullinger, head of that company, Halford found a man who listened to his views on how power might be uprated from 120 hp to 160 hp by increasing the bore, and together they successfully accomplished it. Through this he secured the support of Sir William Beardmore, leading to a new 200 hp Beardmore-Halford-Pullinger variant incorporating aluminium cylinders in threes with steel liners, threaded throughout, screwed into each of the monoblocs in a manner copied from the Hispano-Suiza on which Halford, like Brooke-Popham, had enthusiastically reported to the War Office after visiting France in mid 1915. As a private venture the BHP was offered to de Havilland and accepted, following his introduction to Halford by Hereward de Havilland, thus giving de H. the doubtful satisfaction of testing not only a new aeroplane but a new engine at the same time. C. C. Walker confirmed to me that the first flight of the D.H.4 was made with the first BHP engine, and mentioned that de Havilland had to adapt the nose to accommodate its noticeably greater length. Because the new engine was some 12 per cent heavier than the Beardmore, it meant that the machine was somewhat nose heavy in relation to the undercarriage location.

Genesis from de Havilland's B.E. could be discerned, but to see the D.H.4 was to realize how sturdy and well proportioned it was. Pilots felt confidence in the thick ply forward portion realizing they would be well

protected in a crash, even though sitting immediately behind the engine and caged in beneath the centre-section. Between tailplane and rear cockpit a conventional strutted structure was used employing strong swaged rods for cross-bracing, but the end bays were ply-covered for rigidity. The Irish linen covering on wings and fuselage was left clear doped for early flights, though there were roundels on the wings, and the characteristically shapely rudder carried the red, white, and blue stripe insignia.

Such was lack of caution in trying out new machines that on his second flight de Havilland had no compunction in taking with him Capt G. P. Bulman, who was attached to the AID as an engine specialist. But for influenza, Halford himself would have gone. In de Havilland's skilled hands the flight was a success, and he found the machine stable on each of the three axes, with controls effective and not too heavy, though not finger light like a Scout. As nose heaviness was uncomfortably evident, the next prototype, for which a 250 hp Rolls-Royce had been allotted, underwent major modification whereby the wings were moved forward to the next convenient structural bay, which meant staggering the originally vertical front centre-section struts, and moving the previously heavily raked rear struts forward at their fuselage location until parallel with the front pair. In turn this meant that the wheels must be located further forward to avoid nosing over, so a new V-undercarriage was made, attaching its rear struts to the point where the front members were originally secured, and the latter were moved forward to the next strong point a little ahead of the leading edge. In final form the machine presented even more advanced design than Barnwell's at Bristol.

For some time there could be little hope of large-scale production of the

Geoffrey de Havilland's experience of flying since 1910 gave him particular design insight in making an effective aeroplane. He made the first flights of all his war-time designs and for many years after. (*F. E. N. St Barbe.*)

BHP, but fifty D.H.4s had been ordered a month before the first flight with intention of fitting the Rolls-Royce Eagle as it had become increasingly available since October of the previous year. With this contract de Havilland firmly attained importance as a major designer, establishing with his splendid two-seater characteristic shapes and methods already shown in the D.H.3 twin, and which he was now applying to tentative sketches of small single-seat fighter configurations.

The Aircraft Manufacturing Company had expanded considerably during 1916. A notable newcomer was Arthur E. Hagg, a craftsman furniture designer and amateur sculptor. With his eye for line and proportion and competence at structures he quickly became a valued and forceful member of the team. To accommodate the increased activities, buildings on the opposite side of Edgware Road were taken over, and at the opposite end of Colindale Avenue an administration block was built.

Of this time Hugh Burroughes, who was then general manager, wrote: 'The de Havilland/Holt Thomas relationship was always good. I think de Havilland trusted Holt Thomas's overall judgment commercially and financially, and Holt Thomas certainly had the highest regard for de Havilland as designer. De Havilland and his friends in the RFC personally hatched out the D.H.4 specification, and it resulted in the biggest winner of the 1914/18 War so far as our firm, presently known as Airco, was concerned. Initial installation of the first BHP engine opened a long association between de Havilland and Halford. Unfortunately the BHP was very late before it got into real production, with the result that the Rolls-Royce people, encouraged by the Navy, began their long reign of ascendancy. In fact, Rolls produced more engines than the Navy had aircraft to use them in, and the Navy came along with the proposal that the D.H.4 should be modified to take almost a gaggle of Rolls engines of 275 hp rating. Some were direct drives, some tractors, some pushers, some had right-hand rotation and some left-hand. In every case they were modified and built into the D.H.4 while the BHP engine was still struggling with production problems.

'One of the production problems of that war was fabrication of sheet metal components. We found it difficult to build up a big enough department on the outskirts at Hendon and therefore took another works in Camden Town as a convenient centre for the sheet metal workers of North London, thus solving our fuel tank supply problems. We also started a subsidiary company in High Wycombe to harness furniture makers for the production of wings and other wooden components. This proved worth while, so we started yet another in Penarth, just outside Cardiff. However our major sub-contractor was the outstanding business of H. H. Martyn & Co, of Cheltenham. We got control of their production by forming the Gloucestershire Aircraft Co, with Holt Thomas and Guy Peck, who was our production manager at Hendon, and myself representing Airco; and A. W. Martyn, David Longden, and T. O. Williams representing Martyns. Airco held 50 per cent of the shares and the Martyn directors

held the balance. This company leased the whole of the Martyn works during the period of the War and attained very substantial output.'

In a completely different atmosphere, Shorts were busy with production for their unchanging customer, the Navy. Although manufacture was concentrated at their Rochester riverside works, all landplane testing was at Eastchurch where Ronald Kemp was test pilot. He had just been joined by a newcomer, John Lankester Parker, a youngster who had been stricken with polio, but despite an affected leg had learned to fly before the war and subsequently joined Rowland Ding as instructor at the Seaplane Flying School on Lake Windermere. Here he met Commodore Murray Sueter, who presently told him that Shorts needed an additional pilot. Riding a motor-bike, John Parker called on Oswald Short at Rochester. Always a man of great courtesy, Oswald talked pleasantly to this young pilot, and satisfied with his credentials, suggested he should go to Eastchurch to see his elder brother Horace. 'I like to think that my chances were enhanced by a lucky circumstance,' recollected John Parker in a lecture to the RAeS. 'Horace, as was his custom, met me – and my red painted Indian motor-bike – at his office door. He seemed more interested in the machine than in me, and almost his first words were to enquire what the gadget on my sparking plug was for. I explained that plugs were prone to burn out quickly on this high-powered machine, even when using petrol: with paraffin as fuel they lasted no time at all. To cope with this I had drilled a hole the entire length of the central electrode, thereby allowing cooling air to flow through the plug. A ball valve prevented the return of hot gases. Whereupon Horace glared at me, adopting his gruffest and most threatening manner – a trick of his I was soon to know well. "Young fellar, do you know you have infringed my patents?" he roared. "Come inside and have a cup of tea." I found he had patented an almost identical device, and this little incident made a deep impression on me.

'Anyhow I got the job on three months' trial. But there were still some hazards. I was now officially test pilot at Eastchurch, and as several new aircraft were awaiting test I was on edge to get on with the work. But no, the works manager told me he had received implicit instructions from Mr Short that under no circumstances was the new pilot, "that bit of a boy", to be allowed to fly. I was only 20, and the cap fitted, but I had flown at least a dozen types. After a week of misery I sought audition with the fabulous Mr Short in order to hand in my notice. The meeting did not go as I expected; it was not given to many to hold the initiative for long in dealing with him. I was received with courtesy and a beaming smile – acres of it it seemed, for he had that colossal head – and before I could get a word in he told me that there were four new bombers on the tarmac ready for flight, and I could go in and break my bloody neck. Whereupon Mr Short drove off in his car, ostensibly to avoid witnessing the terrible catastrophe about to take place, but actually to save me embarrassment, for he well knew that these aircraft were very different, much bigger and faster, than anything within my experience. Despite his gruffness he was

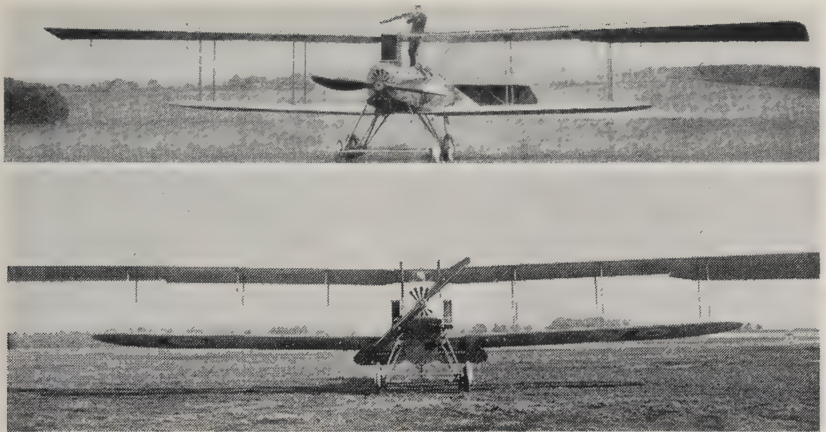
The Short 184D was a single-seat bomber version of the 63½ ft span basic 184 seaplane, and carried nine 65 lb bombs mounted vertically within the enclosed original front cockpit space. The outer landing-wire strops provided tail clearance when the wings were folded.

really a very kindly and highly strung man, and I know that, at some personal risk, he was offering me a great chance.'

These big single-engined bombers had been based on the Short 184 which Westland Aircraft Works and others were building to meet the Navy's considerable demand, despite this long-winged seaplane's marginal performance when carrying a torpedo. As late as 28 May a test pilot at Felixstowe had reported: 'The 184 proved difficult to get on her step – once there, got off easily at 46 knots, (2,200 rpm); climbed to 600 ft fairly well, then shut down to 2,050 rpm and just managed to fly level at 49 knots. Tried at 48 knots and she became very soggy.' Yet the surprising conclusion was: 'Very satisfactory, and a great improvement on all previous attempts at torpedo carrying.'

The Short Bomber in earliest form was little more than a landplane development, using the same fuselage mounted on a massive four-wheeled undercarriage. The initial two-bay wings had a bay added each side with big top wing overhang to give 85 ft. Laden weight was 6,800 lb compared with 5,100 lb for the 184, and with a 250 hp Rolls-Royce it had much the same speed.

By using the 184 fuselage Horace Short had taken a short-cut to quick production – for its stand-by rival, the smaller Wight 840 bomber, would not be ready for many months. Eventually in the guise of twin-float seaplane, the Wight was ordered in modest quantity for oversea patrol against U-boats, and by a twist of fate J. Samuel White & Co next contracted to build the seaplanes of their rivals, Short Bros. However, Horace's expedient with the stock fuselage did not satisfactorily pay off, for even to the eye it was too short for the big wings. Inevitably longitudinal stability was marginal, but with true Short obstinacy the designer refused to acknow-

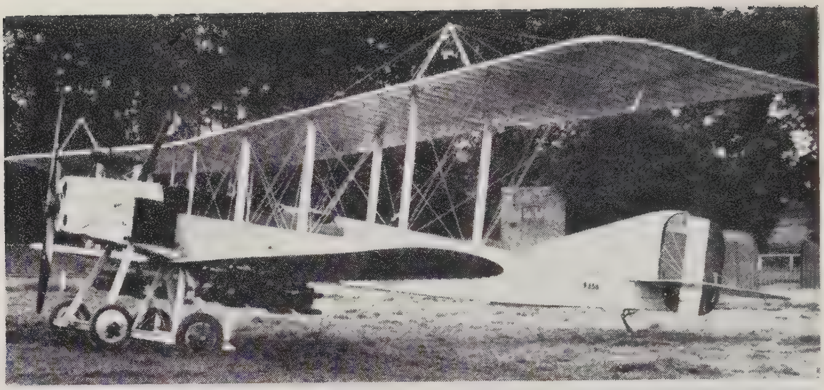


Expediency led to incorporation of existing standard parts wherever possible in new designs. The Short bomber (top) was a quick adaptation of the 184. Greater area was found necessary and the wings were extended (lower). Note gun position to give an all-round field of fire. (*Photos. Short Bros and H. Busteed.*)

ledge he was wrong. So Ronald Kemp connived with Commander Longmore to get Horace invited to Naval Headquarters at Dunkirk, and while he was away they spliced 8 ft 6 in into the fuselage behind the gunner's cockpit, flew the machine and found control and stability enormously improved – then awaited the wrath of the master; but it was officially adopted. Ungainly looking though it was, with controls requiring considerable strength, the robust nature of construction and even the huge size instilled its pilots with a feeling of confidence. If controls were abandoned the Bomber would wallow along without dropping into a dive, whether throttled back or not, for like the 184 it required all one's strength to hold the wheel forward sufficiently to pick up 10 mph.

Strategic bombing of the Saar was the intention behind the Short

No. 9306, the first production Short Bomber. This had the original type of short fuselage. (*Short Bros.*)



Top. No. 9356 long-fuselage Short Bomber built by Sunbeam. The Wight Bomber (bottom) had a span of 65½ ft and gave an impression of ungainly size, like its rival the 85 ft Short Bomber. The top wing surface in effect consisted of two conjoined cambered sections which had been patented by Howard Wright on the supposition that it gave greater lift. (*Top photo courtesy G. S. Leslie.*)

Bomber, but bereft of the 1½-Strutter fighters handed to the RFC by the Navy, the cumbersome Short was too vulnerable for extended operational use. In any case the O/100 would equip the squadrons soon. There is sidelight on the scene from a young naval officer of that time: 'When I went to Eastchurch there was a War Loan drive on. It did very poorly there due to the Short factory still producing obsolete aircraft for the Admiralty. They were factory tested, Navy tested, officially accepted by the AID – then the engine was removed and the airframes burned. "Please lend your money so that we can do more of this," said the disenchanted workers, and precious little was collected. These were Short Bombers on wheels. They just happened to be built at Eastchurch, for Rochester was bung full of seaplanes such as the Bomber's grandfather, the difficult, soggy old 184.'

4

Home-based contingents of the RNAS were primarily engaged on anti-submarine work and night-flying defence of London, and the east coast was delegated to the RFC. On the night of 2 September, a raiding Zeppelin

for the first time was destroyed in English skies. An eye-witness wrote: 'On Saturday night, as early as ten-thirty the "raid feeling" was in the air. It was pitch dark. All lights were out, and half a dozen searchlights persistently wavered round and round one spot in the eastern sky. Everything was quiet with that breathless, expectant quietness heralding a coming storm. At five minutes past two the air vibrated to the beat of distant engines. Searchlights roved the sky in scores. Suddenly, a light flickered on a long bright body and instantly there she was, at least 12,000 feet up, sailing due north, the centre of attraction for the whole outfit of lights.

'In a moment the air was filled with the crash of guns, and shells screamed their passage towards their target. Slowly the airship turned on her course, drifted due north, "crabbing" all the while as though temporarily disabled and drifting with the wind. I saw her quite plainly, end view and broadside on, and give as my opinion that she was a Schütte-Lanz.

'The "crabbing" lasted five minutes, and then she appeared to get under power and bore round until she was steering almost due west, making towards London. Guns were pounding at her incessantly, and from my point of vantage the shells appeared to burst all over her: under and over and at both ends. Suddenly every gun ceased as if by magic, and in the full blaze of the searchlights she sailed ahead. It was an ominous silence that seemed to tell something *else* was about to happen.

'A flicker of flame appeared at her nose, died down, and then burst into bright light for a fifth of her length. It lit the sky with brilliant light that got more powerful as the flames ran along the envelope the entire length. For a few moments I saw her full outline as a burning mass, during which time she continued to travel forward. Slowly, very slowly she dipped, forming a graceful curve, and then stood end up. This was when, as the flames roared up from the front and joined those farther back, the brightest light was shown.

'Where I stood, ten miles away, it lit the streets and woods until one could imagine it a sunset, for the flames were principally crimson. The slow speed at which she fell was amazing. I had expected, once she got nose down, to see her go at a terrific pace. But the mammoth appeared to be a huge mass of flame supported by a parachute. When yet five thousand feet up, the light turned to a brilliant ruby, through crimson and pink to an incandescent white at the top, trailing pale yellow. At that moment there was a crackling as of exploding ammunition, or it might have been twisting girders, or breaking timber. Then she disappeared behind the trees with a crash, and a final flare flashed up. Cheers echoed throughout the whole of London – but in the district where I stood, we had another on our own, as three coloured lights sprang into being and hung motionless in the sky, for we knew them to be the guiding lights for the returning victorious airman.'

He was Lieut W. Leefe Robinson flying a B.E.2c. Like Flt Sub-Lieut Warneford – who a year earlier had attacked and destroyed a Zeppelin near Ghent – he was awarded the VC.

Three weeks later two more Zeppelins were brought down in Essex, and the week after, another fell at Potters Bar. It appeared to spell the end of airships, and immeasurably increased confidence in Britain. Indeed, it seemed we were bound to win the war when it was learned that on 15 September a secret weapon was used on the Western Front, for great grotesque armour-plated Tanks with caterpillar tracks had crossed No-man's land and attacked the panic-stricken Germans with heavy gunfire. Newspapers were quick to publish pictures of these vast machines rumbling across the shell-torn ground, trailing extraordinary twin artillery steering wheels as they pushed through barbed wire and straddled trenches. People thrilled to read of these monster mechanical elephants which could lean against walls and push them over or trample down trees and butt great field guns aside while they fired devastation at the enemy.

Wreckage of a Zeppelin in East Anglia heavily guarded to keep trophy hunters away. At first Zeppelins could attack with little risk, but losses became so great that daylight raids by aeroplanes were relied on after 1916.

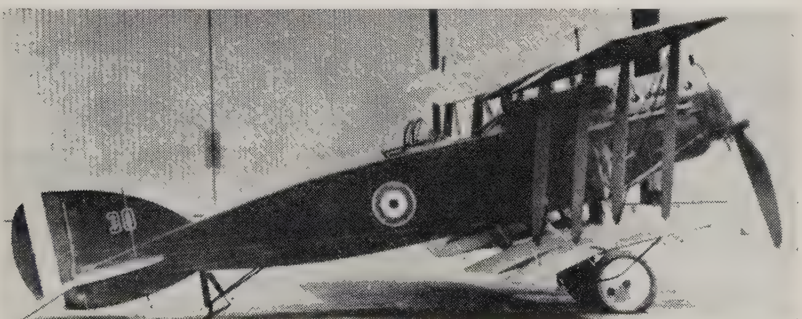
Coincident with the Tanks, its importance to the RFC unrealized, came the initial flight of the Bristol F.2A. Frank Barnwell had excelled himself with a rationalized version of the R.2A he had been devising in March. The bold fuselage tapering symmetrically to a horizontal knife-edge looked right, and its position midway between the wings gave excellent view, though the visual value of the open lower centre-section was doubtful, and it seemed questionable whether the wing-root end-plates could restore efficiency. Certainly the new 190 hp Rolls-Royce Falcon seemed a beautiful engine, totally cowled, like the Armstrong Whitworth F.K.8, using vertical radiator elements each side. Barnwell's assistant, Leslie Frise, recorded: 'I remember as my share of the Bristol Fighter that I was able to

The prototype Bristol Fighter, shown at Filton, fitted with side radiators and lower wing-root end-plates.

complete the whole of the stress calculations, make drawings of a large proportion of the parts, design the airscrew, and then go off to an Army School for a machine-gun course. Within a fortnight I was back with the gun, and making the drawings necessary for its installation in the aeroplane.'

With mechanical machine-gun synchronizing mechanisms proved in operational fighting, Barnwell broke new ground by installing the fixed Vickers inside the fuselage centrally in front of the pilot, with butt protruding through the dashboard and mechanism within reach so that jams could be cleared. For the moment there was no rear gun, but the flat top of the observer's cockpit was designed to take a Scarff No. 2 ring mounting.

In his *Bristol Aircraft since 1910*, C. H. Barnes relates that the technical team, directors, and a great crowd of workmen eagerly gathered on the aerodrome to watch the first flight: 'There was dismay when Captain Hooper reported that the machine could not climb higher than 6,000 ft. Rigging was checked but small alterations of incidence and stagger had no effect. Finally Captain Barnwell sent for his brother Harold, Vickers' Chief Test Pilot, who in turn reported a maximum altitude of 6,000 ft although he felt certain he had climbed very much higher. Then the penny dropped – the altimeter was changed and the fault was found. In fact, the



The prototype Bristol Fighter at Upavon for handling tests on 21 September, 1916. It is seen with nose radiator and Scarff gun ring, and with wing-root end-plates removed. (*Courtesy A. J. Jackson.*)

F.2A had climbed to 10,000 ft in 15 minutes.' On 21 September it was flown to Upavon for preliminary trials, where performance was found even better than calculated, vindicating the Air Board's confidence – for 50 production machines had been ordered at the end of August. To improve the pilot's view they were built with almost circular nose radiators, and the fairing and cowling given more tumble-home.

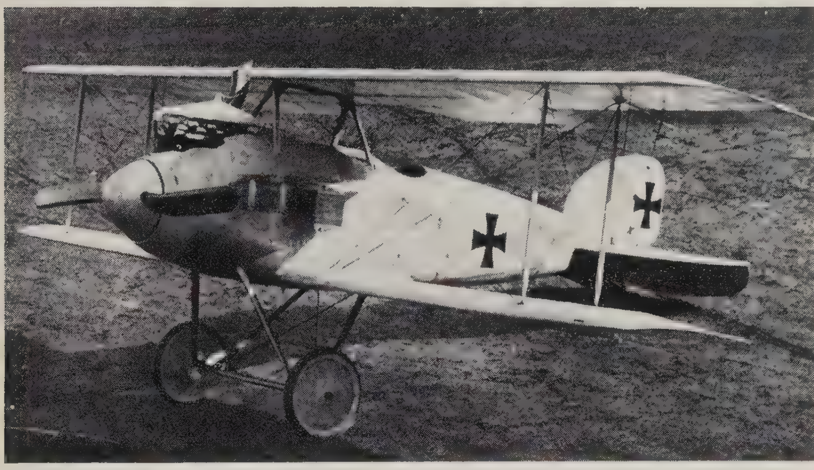
On the day the F.2A prototype went to Upavon it was officially announced that the Deputy Controller of Production at the Ministry of Munitions, Mr Henry Fowler, AMICE, MIMechE, had been appointed Superintendent of the Royal Aircraft Factory in succession to Lieut-Col Mervyn O'Gorman, CBE, now Consulting Engineer to the Director General of Military Aeronautics. Someone had taken at face value the Burbidge Committee's recommendation that the Superintendent need have no knowledge of aeronautics, for he had previously been Chief Mechanical Engineer of the Midland Railway, having originally been apprenticed to the Lancashire and Yorkshire Railway in 1887. But to the staff of the Royal Aircraft Factory it seemed ominous. As C. F. Caunter wrote in his historical summary of the Royal Aircraft Establishment: 'Work continued under the new Superintendent, Henry Fowler, as strenuously as before in helping with the war effort, but it was on a lower and perhaps disillusioned key, since some of its more important functions which it had pioneered with marked success had been taken away and time was needed to settle down to the new way of life.' There is no doubt that the great team of devoted scientists and designers whom O'Gorman had inspired to work in a spirit of selfless enthusiasm did not like working under a new man wholly inexperienced in aeronautics, able though he was as a railway engineer. But his real task was to turn Farnborough scientists into Civil Servants.

5

Writing of the great Somme offensive *The Times* Military Correspondent warned: 'The Germans will continue to struggle desperately to regain some measure of the air supremacy they have lost. The winter will probably see very bitter fighting; but all air fighting is now much closer and more savage than ever before. The importance of air mastery has been more clearly demonstrated, and individual fighting skill immensely increased. With the greater speed of machines, and greater cleverness in handling, the old leisurely combats are no more. Where two aircraft used to fly side by side and empty successive drums of ammunition at each other, it is now a headlong plunge in a single shot; a dip and a swerve and another shot; a loop and a glimpse, and a single shot again – a duel swifter, more breathless and more reckless than any fighting ever was on earth or sea.

'Evidence of new activity has been a great aerial battle, wherein some 70 aeroplanes engaged, which the official *communiqué* stated took place between 9 and 10 o'clock on the morning of November 9th, well over the German lines in the direction of Vaulx-Vraucourt, N.E. of Bapaume, whither our aeroplanes were bound on bombing expedition. With them

were fighters and scouts, making a total fleet of 30. Just before reaching Vaulx-Vraucourt, they sighted an enemy squadron of 36 to 40 aeroplanes. We attacked at once. Of the *mêlée* which followed it is impossible to get a coherent account, for no man had time or thought for anything except the enemy machines with which he was engaged; but for 20 minutes there raged among the clouds such a battle as the world has never seen: an inextricable tangle of single combats, of darting, swirling machines, the air filled with the roar of 70 engines and clatter of guns.'



The Albatros D.I was typified by its shapely ply fuselage, trestle cabane and 150 hp Benz or 160 hp Mercedes engine. Top speed was 109 mph and it could climb to 1,000 metres in 6 min. With a weight of 1,976 lb it was 700 lb heavier than the Sopwith Pup. (*Egon Krueger.*)

They had encountered the new, well-streamlined, Albatros D.I, powered with a 160 hp Mercedes six-cylinder vertical. Its square-cut single-bay wings were of orthodox fabric-covered wooden construction, with ailerons on top wing only, but though most German aircraft had ply-covered fuselages, it had the first full-length, rounded semi-monocoque structure to go into action. If a little blind forward and upward, this single-seat fighter was outstandingly distinctive. Twenty-five-year-old Hauptmann Oswald Boelcke, the great German air ace, initiated its use leading one of the new *Jagdstaffeln* of the recently unified German Air Service. Each class had its own grouping. Artillery aircraft, comprising a mixed bunch of the new two-seater Albatros C.V/16 and D.F.W. C.V, with the older L.V.G. C.II, and Rumpler C.I, had been formed into *Fliegerabteilungen*, and four *Kämpfgeschwader* bombing units were given the job of *Schutzstaffeln* to protect artillery flyers.

Whatever the ability of the new generation of German aeroplanes, there was every indication that British designers would more than match them. Judging by captured two-seaters it was clear that our D.H.4 was way

Balloon attacker Sopwith Pup of No. 8 Naval Squadron, showing typical installation of le Prieur rockets on metal-shielded interplane struts. (*H. Busteed.*)

ahead structurally, and NPL wind-tunnel tests pronounced it aerodynamically the most efficient of its type yet designed. But there could be no sitting back. The Sopwith triumvirate of T.O.M. himself, Sigrist, and Hawker, knew the necessity of being one jump ahead. They gave Ashfield proposals for redesign of the Pup, to be powered with the 110 hp Clerget which would soon be available in production numbers.

This little Pup was endearing itself to every pilot, though it had its minor idiosyncrasy due to gyroscopic effect of the 80 hp rotary, in conjunction with the twisted slipstream, which resulted in many a new pilot swinging off-course during take-off until eventually at right angles. Once in the air the Pup flew with perfect steadiness, for the tail gave considerable stability,

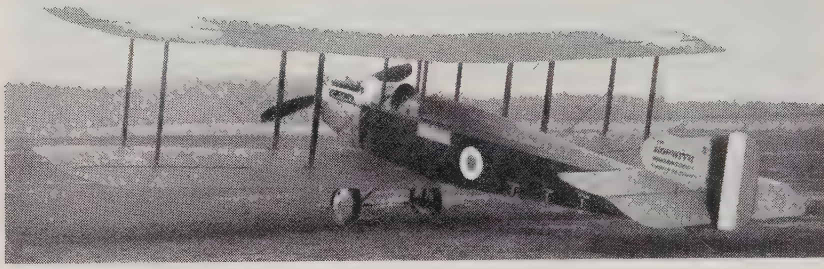
A trim Monosoupape Sopwith Pup about to be started. The under segment of cowling is open to assist cooling. (*Courtesy the Royal Aero Club.*)

yet to hold a vertically banked turn required only light elevator and slight opposite aileron. James McCudden, who at the time of the Somme battles was a Flight Sergeant flying D.H.2s, later wrote: 'I realised that the Sopwith could out-manoeuvre any Albatros, no matter how good the pilot was. When it came to manoeuvring, the Sopwith Scout would turn twice to an Albatros's once. In fact very many Pup pilots have blessed their machine for its handiness when a long way behind the Hun lines and at a disadvantage.'

Despite their pleasant characteristics, Harry Hawker realized both Pup and Triplane were somewhat too stable, and that swifter fighting machines of the future must turn even more quickly or they would find their target gone. Already he had recommended that the Triplane tailplane should be reduced in area. Not only manoeuvrability was necessary to secure victory in a dog-fight, but great rate of climb was essential in order to zoom and dive on the enemy. The value of high aspect ratio was clear from the Triplane; so for the anonymous new F.1, the Pup-type wing should have greater span and smaller chord. A shorter fuselage could then be employed, but in any case a smaller tail than the Pup's would give greater sensitivity.

Sopwith built the greatest number of single-seat $1\frac{1}{2}$-Strutter bombers. Four 56-lb bombs were stowed internally behind the pilot; without them the machine was nose-heavy despite adjustable tailplane incidence. This Westland machine was delivered to No. 3 Wing RNAS at Luxeuil, France.

It was on these lines that Ashfield was instructed to produce the Pup development, and following former practice he traced the outline of a new machine on an overlay of the structural drawing of his previous one, with the front bulkhead as location point, using the same cowling space, undercarriage location, leading-edge location, and stagger, and keeping top and



Developed from the useful $1\frac{1}{2}$-Strutter bomber version, the Sopwith B.1 prototype was tested in the spring of 1917, but was tiring to fly owing to change of trim with speed, and was not put into production as the technical advance was small. (*Courtesy The Royal Aeronautical Society.*)

bottom fuselage longerons of the forward portion the same. The pilot was moved as far forward as possible to get a forward centre of gravity, and the aft length of the fuselage shortened some eight inches, adjusting the lower longeron until there was the same angle between the ground and a tangent from wheel to tailskid. This dropped the fuselage line slightly, requiring the top longeron to be sloped down until it made the stern-post about the same size as the Pup's. The same rudder was mounted, and a fin of similar profile was used except for greater radius to its nose in order to coincide with the narrower chord of the F.1 tailplane.

Sigrist and Smith vetted the drawings for ease of construction and standardization of metal work, deciding that the top wing should be one continuous piece to save weight and lessen complication and building time. This meant giving the lower wing greater dihedral than when shared by top and bottom wings. After a few minor alterations Hawker and Sopwith would agree the result to be satisfactory. 'It was then the task of Carter's office to elaborate our rough work into production drawings, which were signed as approved by Smith as chief designer,' said R. J. Ashfield when we discussed the genesis of this machine. 'In this way the F.1 Camel was built in six weeks from the time my project GA was accepted.' Meanwhile Smith was involved in modifying the $1\frac{1}{2}$-Strutter into a single-seat bomber, using the existing front cockpit for the pilot. He followed this up in traditional Sopwith way by taking substantially the same fuselage and fitting it with the Hispano-Suiza nose and radiator from his unwanted prototype Triplane N.509. To this now long fuselage he proposed fitting two-bay, unstaggered wings of 10 ft greater span, so that the bigger area and greater strength would enable a bomb load of 560 lb to be carried instead of 220 lb. It was referred to as the B.1.

6

In the skies above Flanders the German *Jastas* using the lethal fire power of the Albatros D.I were beginning to achieve something of the ascendancy of the Fokker monoplanes of a year ago. Seven such hunting

squadrons were operating by the autumn, and *Jasta* 2 commanded by Boelcke was outstandingly successful. On 26 October he achieved his 40th and last victory, shooting down a B.E. which fell into the German front-line trenches. Two days later he and his friend Lieut Erwin Boehme, dived on the same target without seeing each other and collided. Boelcke, with wing-tip broken off, dropped at ever steepening angle and crashed into the ground near a gun battery. A great and chivalrous opponent had gone.

A few days later the Commandant at Osnabrück, where a number of captured British aviators were interned, received the following letter from the father of the German pilot:

> 'Ziebigh, nr Dessau, November 12th 1916
>
> Sir – You have been so kind as to send a wreath as last tribute for our son being killed while fighting for his country that had been dedicated by the British Flying Officers interned in the Camp at Osnabrück. We beg to thank you for having granted the wish of the interned gentlemen, and ask you kindly to inform them that their noble display of gallant feeling has been received with heartfelt gratitude, making a splendid impression throughout Germany. Please God, that the chivalrous relations that have ever existed between German and British aviators, and that to our delight has often been displayed by our son, might soon move into the relations of the nations. With heartfelt gratitude towards you and the interned British officers,
>
> Yours very sincerely, M. Boelcke (Professor).'

Gradually the fatally slow B.E.s were being replaced by Farnborough's new R.E.8, but it seemed to be following the pattern of its geometrically somewhat similar sister the B.E.2e. With the first batch delivered to the RFC a series of accidents occurred due to engine failures – for the RAF 4a had not had sufficient air testing to overcome the inevitable snags of every new design. Nor was it helped by the natural apprehension of newly

The pillar-type observer's gun mounting is visible in this early production R.E.8, No. A73. Contrary to general belief this machine seemed quite impressive to RFC pilots and they regarded it as a big step forward from the B.E.2e. (*Imperial War Museum.*)

recruited pilots, whose inexperience led to undershooting or overshooting when forced landing, or dropping heavily and then turning over. With every crash entailing structural damage the R.E.8 burst into flames because the engine was driven back into the fuel tank immediately behind it. Asbestos fireproof bulkheads were not yet standard, with the result that the leaking petrol immediately ignited. Flames are a fundamental fear of any pilot, so this set the stage for increasing concern of other features, and every squadron began to associate with it rumours that the wings of the B.E.2e with similar overhangs collapsed if the pilot pulled too hard on the stick – yet there seems no record of such failure with the R.E.8.

The first of three S.E.5 prototypes, at Farnborough in November, 1916, in original form with gravity tank in the port upper leading edge. The wing-tips were raked like a Martinsyde.

Because of its reputation, new pilots tended to handle the R.E. timorously, holding off bank when gliding to land. The sequence was invariable: 10 mph would be lost because the machine skidded; stalling followed, with inevitable spinning due to the small fin. As the machine had been ordered straight from the drawing board the Royal Aircraft Factory was seriously concerned. Immediate wind-tunnel and full-scale research was put in hand.

The atmosphere at Farnborough brightened in the early morning of 22 November, when the prototype S.E.5, which had been completed two days earlier, was wheeled out for its first flight in the hands of their popular chief test pilot, Frank Goodden – who, in his usual good-humoured way, was chatting to a somewhat tense, fair-haired young man who had a tall domed forehead, and penetrating eyes behind round glasses. This was Henry Folland. Around him were other technicians and officials gazing appreciatively at the little, khaki-painted machine while its Hispano was run up. Goodden buttoned his short leather flying coat, and pulled on helmet and goggles.

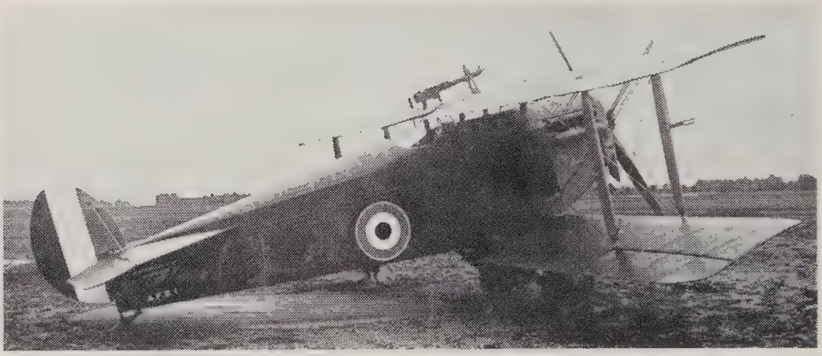
It was 10 o'clock that calm clear morning. He got in the cockpit, re-ran the engine, waved away chocks, and taxied towards the slight slope on the east of the rough aerodrome used by Cody for his early flight attempts. Turning towards the heathland and pines of the western boundary, Goodden opened the throttle for a preliminary run, scarcely airborne, to gauge the controls and stability. Two more – and the little crowd saw he was ready. There was a slight puff of blue as the trim little biplane ran forward, lifted its tail, and mounted steadily into the distance. This was the prettiest, most functional aeroplane Farnborough had yet produced. Completely different in appearance and design techniques from the Sopwith fighters, it gave the same impression of eager 'flyability' though seemed more formidable than the dainty Sopwiths. No paint could camouflage its Farnborough ancestry, for the tail with skid and rudder integrated, the fuselage form, and heavily staggered wings with marked tip rake followed the pattern of the R.E.8.

Presently it was seen returning, the emphatic dihedral giving individual distinction. In a long curving turn over Aldershot, Goodden brought the fighter in with steady glide, making a perfect three-point landing as he touched down 100 yd beyond his starting-point. Returning to the spectators he switched off, put up his thumbs, and said to Folland: 'She's a pixy!'

Next day, shock-headed, long-haired Capt Albert Ball, DSO, the rising air ace, came to try her. On leave from France after destroying ten enemy aircraft and forcing twenty down, he had in mind comparison with his daydream – a stocky, powerful-looking fighter which he had sketched that summer and was trying to get his father, Alderman Ball of Nottingham, who was a director of the Austin Motor Co, to have built.

A 10-minute flight with the S.E. sufficed. After the little Nieuport V-strutted rotary fighters Ball had been flying, he did not like this much more stable machine. Goodden, long accustomed to the many highly stable Farnborough designs, had not seemed aware that the S.E.5 was anything but perfect. Later Ball wrote when stationed at London Colney as Flight Commander in No. 56 Squadron: 'The S.E.5 has turned out a dud. Its speed is only about half Nieuport's speed, and it is not so fast in getting up. It is a great shame, for everybody thinks they are so good and expects such a lot from them. Well, I am making the best of a bad job. If Austins will not buck up and finish a machine for me I shall have to go out on S.E.5s and do my best.'

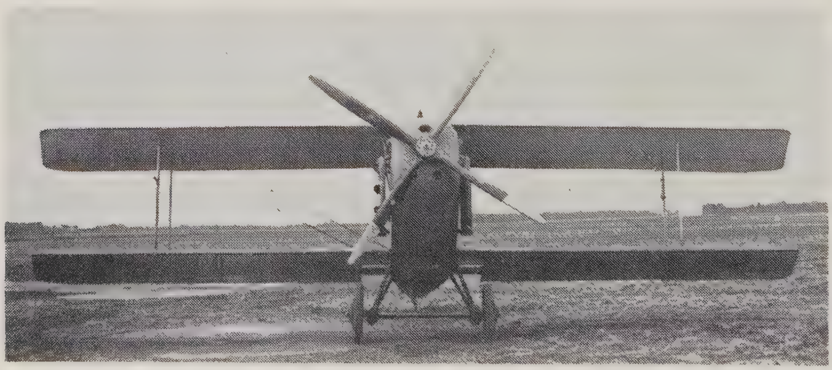
Ball's cherished Nieuport nevertheless had its critics. 'Those Nieuports were stinkers to put on the ground at any time,' said one of his Canadian contemporaries. 'You could make a dandy three-point landing, but just as speed was slacking off they'd suddenly swing hard right or left, tip on a wing-tip, and if you were lucky they'd flop upright again: all our wing-tips were well patched. But they had another and worse habit. At that time Heinie could out-dive us: while being chased down he would probably look back and then tuck his nose down further. To a certain point this was O.K. for the Nieuport – but just a bit more and suddenly it flipped into an



The Austin-Ball fighter was not ready for testing until July 1917, two months after Ball's death. Performance vindicated his belief, but the Martinsyde F.3 was even more promising. Note anhedral and lack of fin as aids to manoeuvrability. (*A. R. Boeree.*)

outside loop. You'd contemplate mother earth while hanging in your seat strap and just as suddenly the action reversed and you'd be heading for the sky. From the start the rudder and stick would be yanked loose until you took hold and got her flying straight and level – feeling most thankful Heinie was gone for good. I also got into an inverted flat spin and think the damned machine came out all by itself: another fellow, who had the same thing happen, agreed.'

Originally an apprentice at Austins, Albert Ball at the age of 18 joined up on outbreak of war, and was gazetted 2nd Lieut in the Sherwood Foresters, transferring to the RFC in January 1916, and such was the limited nature of pilot training that only a fortnight later he was posted to No. 13 Squadron in France to fly B.E.2cs. A brief flight with a Bristol Scout revealed his *métier*, and he delightedly transferred in May to No. 11 Squadron equipped with Nieuport Scouts, quickly establishing himself as a redoubtable lone-hand fighter in the next four months.



This front view of the Austin-Ball fighter shows the cut-outs in the lower wing-roots. These were for Ball to employ his tactic of spotting the enemy below, firing his bottom gun, and diving beneath to fire up with the top gun. (*A. R. Boeree.*)

Typically, this brief operational experience classed him as a veteran, and led him to make sketches and draw up a specification of what he thought would be an ideal fighter. Ball's father handed them to John North, and Herbert Austin agreed the project could proceed if General Brancker's backing was obtained. As a first step, North allotted the task of design to 'a fellow I engaged from Crossley's. I forget his name, though remember he wore glasses. Because he had no experience of aircraft I used to spend several hours each week supervising his work. Young Ball's idea was basically a water-cooled Hispano-powered Nieuport with two upward-firing guns located on a low centre-section for easy changing of magazine drums. We structured and detailed the general arrangement to more practical form.'

When I reminded John North of Sir Herbert Austin's patent, No. 128,634 for 'an aeroplane propeller shaft clear away from the engine shaft and may be tubular and receive the barrel of a gun firing axially through the propeller' he said this was applied to the revamped Spad-like later version but was not Ball's idea. In fact Schneider again was the first patentee of that system, and a similar patent by Birkigt of Hispano-Suiza for a *cannon* gun barrel recoiling through the hub shaft of a propeller preceded the Austin patent by some six months.

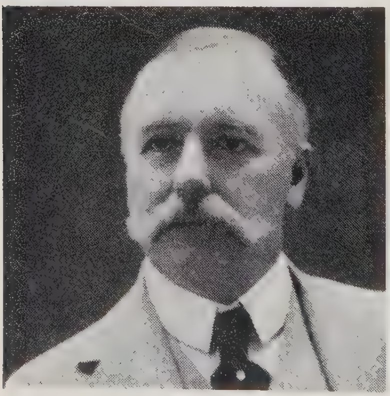
A week after the second prototype S.E.5 returned to Farnborough a third was flown by Frank Goodden. It had an external gravity tank for petrol and water, and was powered by a 200 hp geared Hispano-Suiza giving a higher thrust line for its big propeller.

A similar hub-firing Lewis gun installation was also evolved for the S.E.5, envisaging a geared propeller-drive with raised hollow shaft. J. M. Bruce, records in his S.E.5 *Profile*: 'As originally built . . . no armament was fitted, but the long semi-conical windscreen and small transparent panels just ahead of the rear centre-section struts suggest that the idea of fitting a single central Lewis gun might not have been completely abandoned. Such an installation would not have been possible on A.4561,

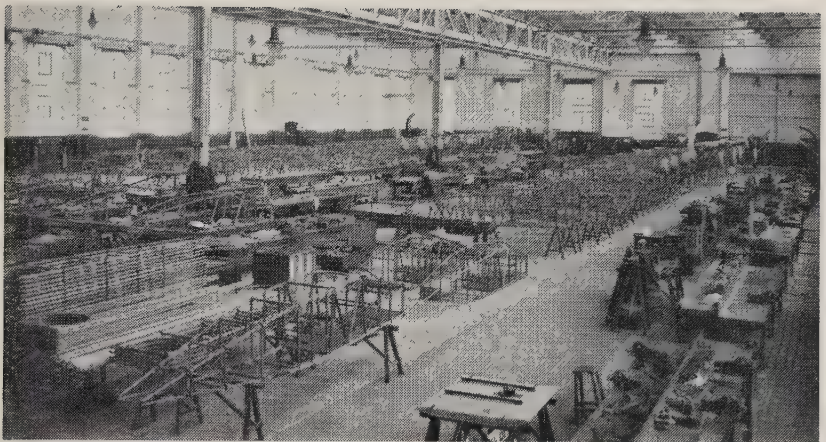
however, for the engine was a direct-drive 150 hp Hispano-Suiza.' He adds that: 'The second prototype, A.4562, was completed one week later than the first, being submitted for final inspection on the 27th November 1916 and made its first flight on the 4th December, but was damaged two or three days later. By the 21st December it had been fitted with a Vickers gun and Constantinesco C.C. synchronizing mechanism, a Lewis gun on a Foster mounting, a new windscreen, and Aldis ring-and-bead sights. Its main petrol tank had been modified, presumably to accomodate the Vickers, and a new gravity tank fitted. These modifications put the aircraft on an operational footing and on Christmas Eve it left Farnborough for France, piloted by Major F. W. Goodden.'

On the day that the S.E.5 first flew, that dynamic baronet Sir George White, founder and head of the British and Colonial Aeroplane Company, collapsed and died. 'Like Sir Hiram Maxim, other directions of the pioneering enterprise of Sir George White tended to obscure his splendid work in connection with aviation,' recorded *The Times*. 'He was principally known for his connection with another form of transport, tramways, but for many years was head of George White & Co, Stockbrokers of Bristol.'

Undoubtedly Sir George White's real memorial was the splendidly engineered Bristol factory. Bay after bay of long peaked roofs stood on the heights of Filton; and half a mile beyond and lower down was the compact aerodrome, with its rows of large hangars. That Sir George was no uncaring martinet, despite intimidating manner and fierce gaze, was often revealed to his pilots – for he had a hidden admiration for them, making a point of watching every important first flight or demonstration or key competition. His 34-year-old son and heir, Sir Stanley White, inherited this side of his personality. Cyril Uwins, his chief test pilot and friend for more than 40 years, described him as 'an extremely shy man, with little technical knowledge, who chose his staff with skill and care and



Sir George White (left) was the shrewd financier behind many Bristol industrial facets, and his war-time aircraft factory, founded in 1910, became the third biggest in Britain. Frank Barnwell (right) was Bristol's experimental designer from 1911 and became chief designer in 1915.



Full war-time production of Bristol Fighter fuselages in one of the spacious shops of the British and Colonial Aeroplane Co Ltd. The final grand total was 5,252 machines.

then relied on them completely. If anything, he was over kind and considerate and always could be relied on in any difficulty.'

A week after Sir George White's passing, Sir Hiram Maxim also died. He had been co-founder of Vickers Ltd when it was Vickers, Sons & Maxim. Few remembered that towards the close of the nineteenth century he made numerous airborne runs with a constrained giant biplane powered by powerful steam engines of his own ingenious design. Said one typical but sketchy tribute: 'So sure was the inventor that the machine would lift, that he had special guards fitted to the track to prevent the aeroplane rising more than a few inches.' In this manner he had made flight after little flight long before the Wrights made their first freely controllable essay.

One result had been his book, *Artificial and Natural Flight*, in which the great extent of his research with wind-tunnel and whirling arm was revealed. Coming at a time when little aeronautical literature was available, it proved of value to many an aspiring designer. Acknowledged as one of the keenest minds in engineering, Maxim doggedly insisted on following his own train of thought rather than be swayed either by the researches or opinions of others. A breezy extrovert, and very strong physically, he was intolerant of those who did not think as fast or accurately as he, so his autocratic manner was often regarded as bumptious, and led to difficulty with many associates – though Dr A. P. Thurston, and several others who assisted Sir Hiram in research and design, were so immensely impressed by his technical knowledge and affability that they would never accept criticism of the man who had tutored them.

7

The winter of 1916 seemed more hopeful than any time since the Germans failed to consolidate their first great rush to the Marne at the beginning of the war. The great Battle of the Somme had raged since July in fruitless

combat inflicting tremendous losses on both sides – yet the British, at the price of greater casualties than the enemy, were constantly if slowly advancing, though there were occasional setbacks. Even the enemy's deep dug-outs were overcome, for we learned the lesson of following close behind our shell barrages, and dropping into the target trenches before the Germans could crawl from the dug-outs where they had been sheltering from the intense gunfire. A continuous yield of prisoners resulted. Germany's General Ludendorff admitted: 'The strain on physical and moral strength was tremendous, and divisions could only be kept in the line for a few days at a time. The number of available divisions was shrinking. Units were hopelessly mixed up, the supply of ammunition getting steadily shorter.'

Churchill threw light on the vast operation by explaining that: 'The anatomy of the battles of Verdun and the Somme were the same. The battlefield had been selected. Around this battlefield walls were built – double, treble, quadruple – of enormous cannon. Behind these, railways were constructed to feed them, and mountains of shells were piled up. All this was the work of months. Thus the battlefield was completely encircled by thousands of guns of all sizes and the wide oval space prepared in their midst.' But now, the trenches had been obliterated and the entire field of action rendered a wilderness of shell holes. The battle had flared into a final great operation on 25 September – but it was almost the end, for the oncoming rain and fog and snow of winter would effectively stop further movement. The British dug in and consolidated the little bulge, some six miles at its deepest, which they had made on a 20-mile front.

Nevertheless, Germany had good cause for congratulation. Roumania, entering the war at the end of August, had been crushed in a mere two months by Austro-German troops – and Belgium, Serbia, and large areas of France and Russia were occupied by the victorious German Army. Indeed Russia was tottering.

Once more outcry arose against the Government and Asquith's leadership. Bonar Law marshalled the Conservatives and Addison the Liberals to secure Asquith's fall when he attempted to re-form his Cabinet. On 6 December it was announced that Lloyd George, the dynamic critic of Asquith policy, had been made Premier. Expressing the jubilation, C. G. Grey wrote: 'I doubt whether the fall of Sofia or Constantinople would cause as much genuine satisfaction; and I doubt still more whether it would affect the progress of the war as much. Even the Battle of Jutland, and the newspaper reports of the Push on the Somme, did not produce the same intense relief, or give everyone the same "Thank-God-that's-a-weight-off-my-mind" expression. It is the irony of fate that once more, as in so many other emergencies, England has had to call upon the Celtic Fringe for her salvation. The little down-trodden, run-to-seed Celtic nations have a curious faculty of producing at intervals, generally in times of great stress, men of outstanding ability. Mr George will make mistakes, but if they are not too frequent all will be well.

'In his specific dealings with aeronautical affairs, which fortunately have

been infrequent, Mr Asquith's influence has been as unhappy as in all his other dealings. One recalls his action in appointing a "Judicial Committee" to investigate so called charges against the administration of the Royal Flying Corps but refused to include the Royal Naval Air Service, presumably out of deference to his old friend Mr Balfour. The result is that the RNAS – except for a few bright spots – has steadily gone from bad to worse, whereas the RFC has undertaken and nearly accomplished its own reformation, besides carrying out an astonishing scheme of expansion.'

The RNAS was encountering heavy criticism. Sweeping changes were taking place in the Board of Admiralty, and *The Times* published a letter by Joynson-Hicks indicating that a scandalous state of affairs existed in the administration of the Naval Air Department. 'It is known who is responsible for the neglect; why was he not relieved or removed?' he asked. *The World* followed up by stating: 'There is one officer whose name is on many people's lips, who has been a leading figure in the Royal Naval Air Service for the past six years, and whose features would be familiar to readers of the *Daily Mail* as one of the blessed trinity whose photographs appeared as the man responsible for the Tanks.'

The paper's correspondent then plunged whole-heartedly to the attack: 'Commodore Sueter has no false modesty. He may be called an "above board" man, for we well remember when he was Director of the Naval Air Service how grateful the whole Press was for information on the dashing exploits of the Naval aviators in the early days of this dreadful war. A full measure of kudos was given him at that time; but of recent years, as war dragged on, the campaign in which Commodore Sueter has taken the most active part is the "Whitehall Front" between Navy and Army Air Departments. The Naval blockade seems to have been particularly effectual.

'One of the first things after Mr Balfour's appointment to the Admiralty was the announcement of a new Director of the Air Department – it was said for disciplinary purposes. A new job (accompanied by the usual promotion in such cases) was found for Commodore Sueter as Director of Supplies: which includes aeroplanes, dirigible balloons, motor-cars, motor-lorries, motor-boats, and in fact every sort of appliance that may be considered accessory to the Naval aviator. The Commodore lost no time in recommending the spending of millions of public money, and in order to convince MPs of the result of this large expenditure the Air Department invited them last Friday to a "trip down to the sea". A special train was provided, with elegant lunch and outdoor amusements. We hope that, as a result of their trip, these MPs will express by next Tuesday their views as to whether the millions referred to have produced the quality and quantity of material of corresponding value in defeating the enemy.

'Undoubtedly from an eyewash point of view there were wonderful things to see. The gallantry of the Naval pilots ensured such toys as were submitted did their tricks well. One of these was the marvellous No. 1000 Type machine which succeeded in delaying production of almost every

The Blackburn-built A. D. Scout flew better than its appearance suggests, and was designed around the Davis two-pounder quick-firing recoilless gun which projected through the aperture shown in the nose. The side footsteps were for gun servicing. (*Courtesy National Aviation Museum, Ottawa.*)

other type of seaplane for over a year, and cost the country untold thousands.'

The axe was then swung with a deliberation that indicated the interrogator knew the disastrous answers to the questions he publicly put to the Commodore:

1. Is the No. 1000 Type seaplane a success?
2. Was the Admiralty invention, the Sparrow machine, a success?
3. Is there a dirigible machine within measurable distance of success?
4. What is the total sum of money expended to date on these failures?
5. How many other types of aeroplane and seaplane produced by British manufacturers have been neglected, and even suppressed, to give the Admiralty failures open field free from competition?

It so happened that Commander J. W. 'Jack' Seddon – that Naval inventor of an extraordinary pre-war biplane built by Accles and Pollock on a system of tubes bent into circles, and who was chief experimental pilot at Eastchurch – had flown both the great A.D.1000 seaplane and the unconventional pusher Sparrow, creations of Harris Booth's fertile mind.

The Sparrow had been completed by Blackburns earlier in the year. Seddon described it as designed 'to provide an aeroplane sufficiently rugged to be capable of repair anywhere where a village blacksmith and a carpenter could be found.' Though an ugly machine of remarkable angularity from whatever stance it was viewed, Seddon found it pleasantly stable when he flew the Sparrow at Chingford, but its narrow undercarriage made it dangerous to land on rough ground, and the huge-span elevator and small rudder made control co-ordination impossible. Arthur Longmore was watching the trial, and damned the machine so completely that the Air Department was forced to abandon the project. Nevertheless it

sufficiently encouraged Harris Booth to give another contract to Blackburn for a similar machine in the form of a triplane, but this time with rudders as outrageously large as the elevator and tailplane.

Seddon made the first flight of the A.D.1000 twin-fuselage triple Sunbeam powered seaplane, and on its second trial, flew it from Cowes almost to Felixstowe, laden with three-quarters maximum fuel and initially carrying three passengers – allegedly amounting to a total load of ten tons and thus far exceeding its rival, the Handley Page O/100, which lifted six tons all-up on half the power of the A.D.1000. He recalled: 'It was flat calm,

The giant A.D. 1000, showing its deep glasshouse nose and diagonal radiator ducts. The 30 ft span Wight Baby awaits test alongside. Handley Page's successful O/100 demolished the chance of A.D. 1000.

and it took 15 miles to unstick and get airborne, but could not attain more than 70 knots, which was not far above stall – but with every few miles it began to fly with more life. In my report I was able to give unstinted praise to its handling qualities both in the air and on the sea – but I pointed out the immense reduction of resistance and weight if the bullet-proof glass greenhouse was replaced with an open Maurice Farman type nacelle, and the appallingly heavy short floats, with armoured steel bottoms, were changed for the lighter streamlined White seaplane type of stepped floats.' It was indicative of the hazards of those days that when Seddon neared Newhaven an oil pipe on the port tractor engine failed, and an alighting had to be made at sea. After repairing the pipe and shedding a passenger, the journey continued next morning; but off Clacton the oil pipe of the central pusher engine broke, forcing the machine down, and after drifting some time it was towed by the Clacton lifeboat to Felixstowe where it languished unused, as it was clear that the H.P. O/100 could do the Navy's bombing job in more practical fashion.

With the ball at his feet, Frederick Handley Page initiated Christmas festivities by entertaining employees in the King's Hall of Holborn Restaurant. Dense fog caused him to arrive half an hour late – but it had compensation in giving the seated guests opportunity for a great ovation 'which must have effectually removed any lingering doubts he may have entertained as to his personal popularity with his work people'. From the chair of honour hitherto ably, if not so completely, occupied by his brother,

Theodore Page, the great H.P. replied with his usual brilliant eloquence to the toast 'Success to the old Firm', driving home the lesson that the weight-lifting records achieved by the O/100 should incite redoubled effort 'and certainly to double the output of work,' he slyly added. However, C. G. Grey had the last word by saying: 'In something well over 20 years' experience of factories of all sorts, I cannot recollect seeing as many nice-looking, smartly turned-out girls in the employ of one man, but I have seen many a revue chorus which would simply fade away if put up in competition with them. If they continue to take the same pride in their work as they do in themselves, the success of Handley Page aeroplanes is assured for ever!'

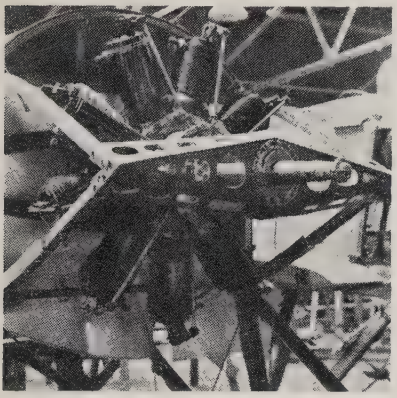
8

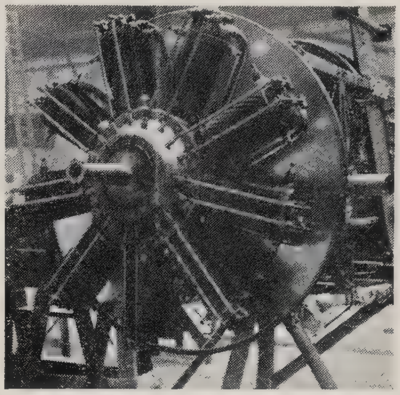
In serious contrast to the gaieties of Christmas was the issue of the Final Report of the Judicial Enquiry into the Administration and Command of the RFC. Signed by Mr Justice Bailhache and his Committee, it comprised 25 foolscap pages, and commented that although evidence was taken on 22 days, and 54 witnesses were heard, there was as much reluctance of junior RFC officers to appear as with aeroplane and engine builders, of whom only three or four gave evidence despite the Committee's repeatedly expressed wish to hear Trade witnesses.

The Report was an excellent historical review of the pitfalls in establishing a new fighting arm. The Committee made clear that although the RFC command had been charged with lack of imagination in foreseeing the number and types of aeroplane and engine which later events proved would be required, it was a fundamental that aeroplanes must be built to suit available engines and not engines to suit aeroplanes. 'For purposes other than fighting, high-powered engines and big aeroplanes are wanted. They are required for long reconnaissance; weight-carrying with wireless, bombs and the like; artillery observation; and especially for mounting a gun to attack dirigibles. At one time it seemed they might be required for fighting also, but the present view is that a small, easily manoeuvred, fast machine is necessary.'

The charge of want of foresight came to this: failure to anticipate the necessity for high-powered engines and to provide for their production. 'The Royal Aircraft Factory was designing a 200 hp water-cooled engine before the war, and had proceeded some way by August 1914,' the Report explained. 'General Henderson, as one of the judges at the engine competition that year, was of opinion that higher-powered engines would be required, but hoped private firms would develop them. He therefore handed the drawings to Rolls-Royce and Napier, but the former declined and independently designed their 250 hp engine of which deliveries are just beginning. Napiers agreed to participate, and the joint effort resulted in a 200 hp engine now under test, the somewhat longer delay inevitably arising from the difficulties of joint collaboration. Although General Henderson stated that he made a serious mistake in stopping the 200 hp

RAF we do not agree, nor suppose that the opposite action would have resulted in earlier production. It has been argued that General Henderson, as Director-General of Military Aeronautics, is responsible for the Royal Aircraft Factory. It is to his credit if it does well, to his discredit if it does ill. It is therefore natural that he should prefer the designs of the Factory whether for aeroplanes or engines.'





The 100 hp Monosoupape Gnome (left) had forward supports in a bull-nosed mounting for the Sopwith 807 and Schneider Baby, but later aircraft, as exemplified by this 110 hp Clerget in the Sopwith triplane (right), used an overhung mounting based on the Bristol Scout. Note the triplane's centre-section strut attachment in the fuselage. (*Courtesy H. F. King.*)

As much of the case hinged on engine supply, the Committee made clear that Henderson lost no time in ordering the rotaries and the aircraft which they would power, although delay occurred in obtaining the 110 hp Le Rhône because it could only be procured with the permission of the French Government who needed it for their own Flying Services. Subsequently there was difficulty in getting the water-cooled Hispano-Suiza, although the opening negotiation had been prompt and a draft agreement sent to the manufacturer on 3 November, 1915; but the answer miscarried, and matters dragged until 22 February, 1916, when the Directorate took negotiations to a successful issue. As for the 200 hp RAF Napier the Committee endorsed General Henderson's explanation that sometimes one must gamble on engines by ordering large quantities, but agreed that its quantity production instanced too great reliance on the Royal Aircraft Factory: they therefore could only refute the idea that no undue preference was given to the Factory, although it was true that several aircraft firms had been given contracts for experimental machines at government expense, and the Directorate had requested some private firms to design aircraft for certain high-powered engines, but so far without result. The wit who wrote the Report added: 'It is obvious that, in designing aeroplanes, opportunity and accomplishment are not interchangeable terms.'

Criticism that the Factory was both competitor and judge was rejected,

for the Committee did not believe any private manufacturers entertained that opinion; but when it came to the question of their designs being submitted to the Factory: 'Private makers furnish stress diagrams, which are submitted to the Factory technicians, and this may have led to some misapprehension. That does not entirely dispose of the charge, and we think there is some substance in it. No one on the actual staff of the Factory – from Superintendent downwards – has any voice in the selections of either aeroplanes or engines. The ultimate decision rests solely with General Henderson. Naturally he seeks advice, and an advisory staff makes preliminary investigations of new types of aeroplane and engine and reports to General Henderson, and he may also consult RFC officers of special experience. The procedure is that general arrangement drawings are sent to the War Office and are examined in General Henderson's office by technical officers who take note of engineering points. An experienced pilot, who deals with the supply of aeroplanes, also examines the drawings. The Inspection Department is consulted, and General McInnes himself inspects and examines the drawings. They are then submitted, with the criticisms of various officers, to General Henderson who accepts or rejects. When an aeroplane is submitted for trial it is sent to the Central Flying School and is tried before the Commandant, two or three officers, and the Chief Inspector of Aircraft.

'In substance, although great pains are taken to prevent the Factory from having direct voice on the selection of either aeroplanes or engines, nevertheless most of those advising General Henderson, and who test the aeroplanes and engines, belong to the Department controlling the Factory. Under existing conditions we do not see how the feeling of the Trade can be removed that their designs may not receive fair treatment or their finished products fair tests in competition with those of the Factory.'

It was agreed that though many of its designs had done good service, the Factory must be judged by its principal achievement – the B.E.2c with the 90 hp RAF engine. The B.E.2c was strong; the design aeronautically sound; and drawings so complete that many new to the Trade, who could

Coming home to roost – a B.E.2c returns from its reconnaissance mission through the gloaming of French skies at sunset. The observer sits high for better view of hostile aircraft. (*Flight Photo*.)

not otherwise have done so, were able to build an aeroplane for the first time. The Committee quoted Algernon Berriman, chief engineer of the Daimler company, who said: 'The RAF engine and the B.E.2c aeroplane have their defects, but they form a combination that has been instrumental in enabling the Flying Corps to perform invaluable service to the Army in France.' The Committee pointed out that all three airships brought down in flames on 2 September, 23 September, and 1 October had met their end at the hands of pilots flying B.E.2cs.

There were charges that the 90 hp RAF was constantly altered in detail, thus creating delay and confusion, but to some extent these modifications were introduced to meet sub-contractor's views and difficulties, though much arose from operational experience as it had not been understood that engine design was an imperfect art, requiring much development air testing. In fact, many engine manufacturers were grateful for the assistance of Factory personnel, and in testimony one Trade witness said: 'It would be impossible for me to go away from this Committee without expressing the gratitude I feel towards General McInnes and every officer of every department, from the head of the War Office to the bottom of the War Office, for the assistance which is given to me. There is every possible ambition to help me succeed in the very difficult work I am doing, and I for one would disassociate myself from any adverse opposition in respect of General Henderson and his staff. People say that they do not seem to help manufacturers and contractors, but I have had nothing but the utmost assistance a human being could have.'

So through a variety of unreal and anachronistic charges relating to insufficient training of pilots and observers, loss of mastery in the air, and defects in aerodromes and ground lighting systems, the Committee reached its main conclusion: 'No-one could complain if Mr Pemberton Billing had asked that these cases should be enquired into to ascertain whether the deaths of these men could have been prevented. But based upon these accidents, a charge of criminal negligence or murder is an abuse of language and entirely unjustified.'

In a final *amende honorable* the Report stated: 'A microscopic examination has disclosed some mistakes, as we think. How could it be otherwise? General Henderson has told us that the responsibility is his for such shortcomings as there are. We ascribed them to the difficult position in which he was placed. The gratitude and thanks which are due for the great work devotedly undertaken and well done, he will, we know, be glad to share with the officers and men who have served under him, whether as Commander of the Royal Flying Corps or as Director-General of Military Aeronautics.'

Engineering of 29 December summed the position: 'Fortunately our troubles are mainly in the past. The Committee has made certain recommendations, of which the principal is that the Equipment of the Royal Flying Corps should be entirely separated from the Executive Command and that the Royal Aircraft Factory should not become a manufacturing

The prototype Sopwith F.1 Camel at Brooklands on a winter's day. It had a one-piece wing and ailerons terminating at the interplane struts. It was hoped that the sloping decking would eliminate need for a windscreen. (*Imperial War Museum.*)

establishment. The latter has produced some unsatisfactory designs of aeroplanes, but, says the report, "the RAF exists to make experiments, and it is inevitable that some experiments must fail". There has certainly been a good deal of dissatisfaction in the Trade about the Factory, but no one came forward to place his complaints before the Committee, so it is probable the Factory furnished a target for every missile of irritability. The authorities there had a thankless task anyway, for they were blamed if they did not press matters forward at all costs, and they were equally blamed if they did not achieve perfection at the first attempt. They had also to deal with many manufacturers who had no previous experience with aeroplanes and had to be watched most carefully. On the other hand there were other manufacturers who needed no instruction, and indeed were more fitted to instruct than to learn. Such diversities of practice do not fit in well with Government control, and give rise to complaints which are inevitable. However, in spite of all these difficulties we have achieved command of the air, and the credit may be fairly divided among the Royal Flying Corps, the Royal Aircraft Factory, and the engineers of the country. The advance in engine construction has been very largely due to the engineering firms of the country, and as the Aerial Service is dependent for its efficiency upon the engines, it follows that our manufacturing engineers can justly take a large share of the credit themselves.'

At the very moment the editor of *Engineering* was writing his editorial the new Sopwith F.1 Camel fighter was being cleared by the company's Experimental Department. On the first clear day after Christmas, Harry Hawker made its initial flight at Brooklands. It was a fierce, wicked-looking little biplane, and even the light-handed Hawker bounced into the air on that first flight, so sensitive was the fore and aft trim. Swiftly and steeply the stubby-bodied little aeroplane climbed high over the banked concrete rim of Brooklands racing track, and soon was a speck in the distance.

CHAPTER V

STRUGGLE TOWARDS PERFECTION 1917

'You ask yourselves doubtless if this apparatus, so marvellously adapted for aerial locomotion, is susceptible of receiving greater speeds? It is not worth while to conquer space if we cannot devour it. I wanted the air to be a solid support to me, and it is. I saw that to struggle against the wind, I must be stronger than the wind, and I am.'

Jules Verne (1886)

1

JANUARY DAWNED discouragingly for Handley Page even though the first operational O/100 had been flown to the RNAS 5th Wing at Dunkirk the previous November with Sqn-Cdr John Babington, Lieut Jones, and Sub-Lieut Paul Bewsher as crew, and two weeks later the second was delivered by Sub-Lieut Waller. The next was disaster.

Lieut Vereker, a promising young officer well acquainted with the O/100, attempted to deliver the third on Christmas eve, but was delayed by weather until late morning of 1 January. Through mist and overcast he managed to attain clear skies – no small feat with instruments suited only to visual flight – and presently his experienced observer-navigator, Lieut Hibbert, calculated by dead-reckoning that they were near Dunkirk. Breaking cloud at only 500 ft Vereker found no identifying landmark, and when he saw French troops working in a big field, landed to enquire direction. Too late he discovered these were prisoners 12 miles inside enemy territory near Laon, and the machine was captured before Vereker could take-off again.

Sourly, C. G. Grey commented: 'After the lesson of the RFC's first de Havilland, which was shot down the day following its arrival; after the F.E.2d with the first Rolls-Royce, which Mr Littlewood landed in German territory direct from England; and after the first French flying-boat fitted with a Hispano-Suiza engine had alighted off Ostende in mistake for a friendly port and was courteously towed ashore by Huns – one would have imagined that even the RNAS administration would realize the proper thing to do is to send new machines abroad in quantities in full fighting trim, straight into action, so that they come as a surprise to the enemy. As it is, new types either land in the enemy lines, where they are examined

The Gotha G. IV, illustrated, together with the Friedrichshafen G. III were the raiders on Britain. A much publicized feature was the gun tunnel in the fuselage bottom so that the gunners could fire not only up and back, but also down. (*A. Imrie.*)

and gauged as to performance, or they hang about on aerodromes in Flanders where they are seen by spies.'

Though the Germans made much of the capture of the O/100, loss of the machine could have no effect on the course of the war. Certainly an expensive machine had been thrown away, and Handley Page's special constructional features might be recognized and incorporated in later German designs; but already the enemy had produced significant equivalents in the twin-engined bombers of slightly smaller size built by the Gotha Waggonfabrik to Hans Burkhard's design, and the Flugzeugbau Friedrichshafen founded by Count Zeppelin.

To the British populace, whether factory worker or MP, capture of the 'Giant' Handley Page was a blow to national pride, and sounded a disaster. Much was made of it amid a welter of discouragement following a 50 per cent increase in rail fares, compulsory use of whole grain for bread giving a dark loaf and less palatable texture, limitation of sugar for sweets, and outcry from potato growers because prices had been fixed at low level. Increasing impact of war was even more forcibly brought home when an East London munition factory exploded, killing 69 and injuring 45 others, as well as wrecking several streets. It was widely felt that such disasters would increase because too many untrained workers diluted skilled labour. 'The quicker the war is over the sooner we can return to peace' had become a ritual greeting, so it was not surprising that the new War Loan produced £1,000 million, though this was assisted by propaganda from the pulpits indicating that the Lord was backing the righteous – an aspect which did not escape the Prudential Assurance who purchased £20 millions.

Adding to the uneasiness, the home skies presented a nightly menace. In 1915 there had been 23 Zeppelin raids, resulting in 181 killed and 455 injured. In 1916 there were 34, bringing the total to 452 killed and 923 injured. But it was the disturbance and lack of sleep rather than the damage which affected everyone's nerves. Sometimes there was near panic: men, women, and children at the merest rumour of a raid flocking to the Tube

stations, and for a penny ticket staying all night. More serious was the jolt to production because workers downed tools and went home – and over a vast area rail traffic would come to a standstill. Increasing criticism in Parliament expressed widespread fear that Home Defence was ineffective.

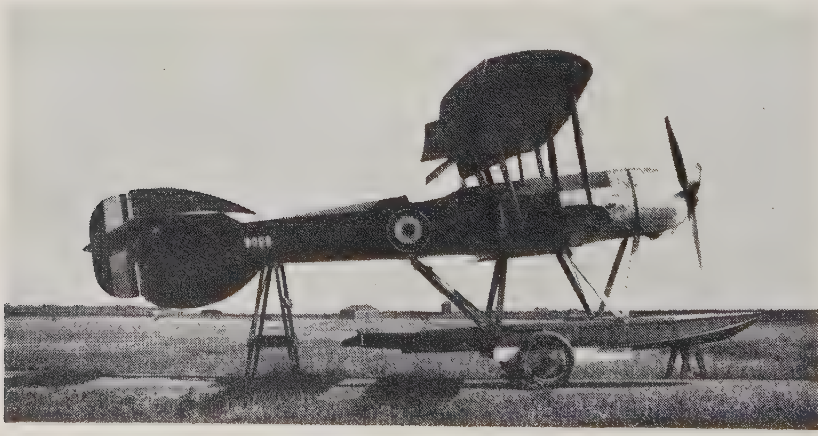
There followed long-expected changes of administration. Commodore Murray Sueter, CB, who had been Superintendent of Aircraft Construction ever since the post of Director of the Air Department had been abolished late in 1915, was quietly removed from office on the score that he must follow Naval tradition and undertake active service. Rumour had it that he would become Commanding Officer RNAS South Italy. The head of the RNAS, Admiral Vaughan-Lee, resigned from the Service, and his place was taken by Commodore Godfrey Marshall Paine, CB, MVO, the first Commandant of the Central Flying School, who was also appointed Fifth Sea Lord. Lieut-Gen Sir David Henderson, KCB, DSO, retained his position as Director-General of Military Aeronautics with membership of the Army Council. Both he and Commodore Paine were to be members of the augmented Air Board, of which the Rt Hon Viscount Cowdray was appointed President, with Major J. L. 'Johnny' Baird, MP, CMG, DSO, as Parliamentary Secretary. One of their urgent tasks was to reorganize aeronautical supplies, for which purpose one of the Board, William Weir of G. and J. Weir & Co Ltd, well-known engineers of Glasgow, was appointed Controller. The Hotel Cecil, with the exception of the east wing which housed the Constitutional Club, was commandeered by the Office of Works for the reconstituted Air Board. Here the RNAS department dealing with *matériel* was to be housed, as well as their opposite numbers in the RFC hitherto stationed at Ad Astral House. A contemporary bitingly commented: 'Any little arguments between the two Services are understood to be in abeyance at present, and apparently a flag of truce has been hoisted while the furniture vans are at work!'

The prototype Norman Thompson N.T.2B ready for delivery. The wing fins were deemed necessary to counteract the low side area of hull and floats. Over 150 of these machines were built, though only 23 were operational at the end of the war.
(*T. Elsemore.*)

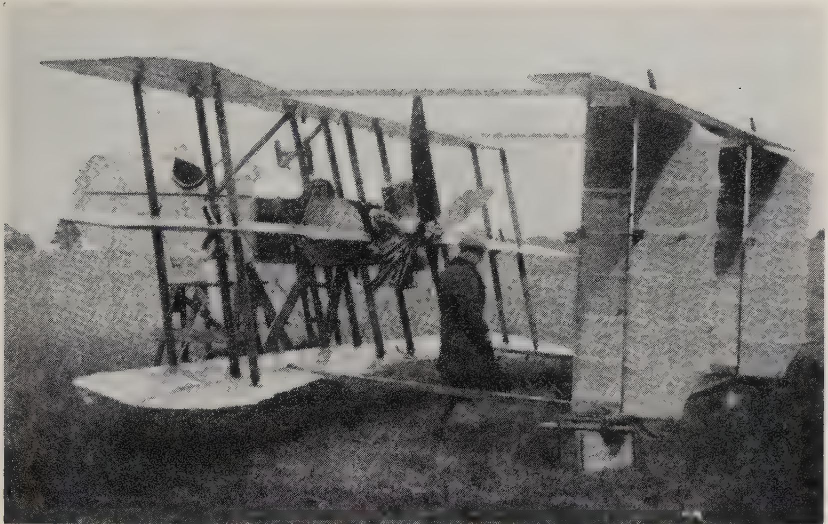
The new organization was widely welcomed by the aircraft industry. C. G. Grey expressed the prevailing outlook: 'One hopes that those responsible for output will recognize that, while rapidity is essential and may be greatly increased by causing each firm to concentrate on one type of machine or engine, it is equally important that every firm should be encouraged to produce experimental machines in the hope that the result may be better than anything which is at the moment in use.' That had largely been Murray Sueter's policy, but as Grey explained: 'The Commodore's difficulties were largely increased on the outbreak of war because nearly all his best officers rushed on active service, taking their hard-earned aircraft knowledge. At the same time the technical staff of the Admiralty had to be increased to handle the demand for more and more aeroplanes. The result was disastrous. Man-power and *matériel* were wasted at a rate that would stagger the imagination if expressed in figures. Young men who would have considered a £5 note to be wealth before the war were let loose to handle money in thousands of pounds at a time. Figure-juggling theorists found themselves in a position to put their inaccurately calculated theories into practice. Absurd machines were built at vast expense. Perfectly good aeroplanes were altered to agree with unproved ideas, and ruined as flying machines in the process.

'Whatever may be the fate, or the development of the Royal Naval Air Service in the future, whatever may be the outcome of sea flying in war or peace, whatever our Naval aviators may do against enemy fleets on sea or in air in time to come, let it be remembered that the man who was father of it all, the man who devoted seven of the best years of his life to building up Naval aeronautics, was Murray Sueter, post-Captain and Commodore in the Navy of His Majesty King George V. This is a matter of history.'

Strictures on the Navy's technicians were merited to no greater degree



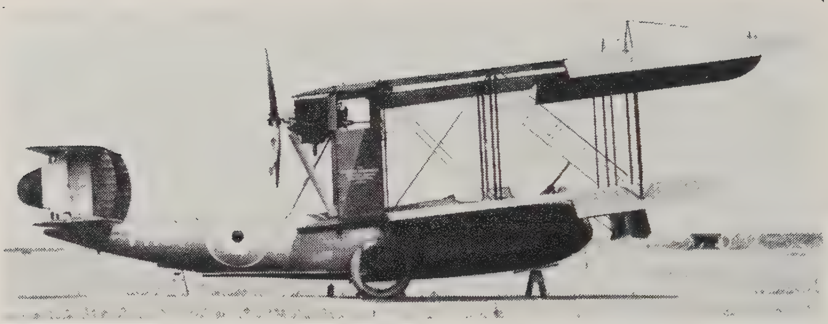
The Wight Baby was tested by Marcus Manton, the famous looping partner of B. C. Hucks, on joining the company in 1916. To simplify folding, the double camber wings had single acting ailerons which drooped when not in flight. (*H. Busteed.*)



The Blackburn-built A. D. Scout biplane had rudders which were too small, but those of the triplane were excessive even though remote from the slipstream.

than other newcomers at the War Office or Farnborough. Some of Harris Booth's wilder imaginative ideas, such as the A.D.1000, Blackburn's Sparrow pusher and triplane development, might not be particularly successful, but it was his technical backing which led the Navy to order the Handley Page O/100, $1\frac{1}{2}$-Strutter, Pup, and now the Camel straight from the drawing board. In the A.D. flying-boat a new and advanced type had been built opening new methods of construction, though it had inadequacies as a flying machine, for John Lankester Parker said: 'If my memory serves, it was the only aeroplane of any form which thoroughly defeated me on my first attempt. Not only did it develop a formidable porpoise at very low speed, but nothing I could do would prevent it turning in ever smaller circles to the right, whether on land or water, despite the fact that my passenger went out to the port wing-tip to keep one float well and truly in the water. Only by opening up down-wind, could one get control when it turned by itself into wind.' Perhaps this handling difficulty is not surprising in view of the small rudders which were typical of designs inspired by Harris Booth and developed by Harold Bolas.

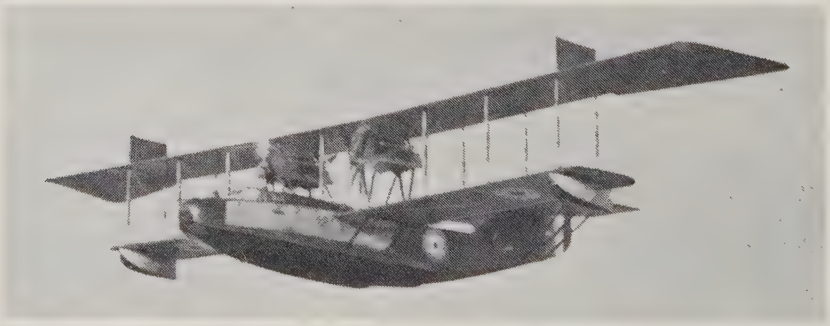
To correlate practical experience with tank results, G. S. Baker, the king-pin of the NPL William Froude national model-testing tank, made periodic visits to Felixstowe, Calshot, and the Isle of Grain. At the latter he found the A.D. flying-boat porpoising badly during acceleration and deceleration. After initially hunting at 25 knots, it lifted on to both steps at 30 knots with the aft water plume just clear of the tailplane, accelerating quickly to 42 knots when it tended to hop clear of the water only to drop on again and then bounce off once more, though it did not change attitude. The tail-plane was thought too low relative to the propeller slipstream, but this was



Folding the wings of a pusher presented the problem of fouling the engine and propeller, but was neatly solved on the A.D. flying-boat by folding forward. Second prototype (above) mounted a Lewis. (*Fleet Air Arm Museum.*)

too big a job to tackle, so the step was moved 2 ft aft in hope of improving the running characteristics, but on each run it still porpoised during acceleration and often a new start had to be made. At that point the Air Department refused to sanction further trials, but a slightly modified version was contracted for limited production by the Supermarine Aviation Works.

The America-type flying-boat was giving more limited trouble at Felixstowe. On test: 'The machine rose and settled three times,' reported Baker. 'The pilot held the tail down on the water until 30 knots was reached then decreased the angle so that the tail came up, after which flying speed was quickly reached. To lift the tail earlier than 30 knots would mean throwing up a lot of water. The machine took a little time to reach the speed of 30 knots, but when the tail was lifted it accelerated rapidly. The air balance was fairly good and the machine moved but very slowly from its longitudinal trim.' This was followed by tests later with the Felixstowe F.1. which Porte had derived from it. 'On practically smooth water and with no wind, both with the elevator full up and down, the flying-boat failed to unstick the tail.' It was clear that much experimental work would be required to develop effective marine aircraft.



The Felixstowe F.2A with two 360 hp Rolls-Royce Eagle VIII engines was the production version of Porte's redesign of the Curtiss H-12. (*T. Elsemore.*)

The SPAD S.XIII – with a hefty swing over compression the Hispano-Suiza is started. Chocks only came into general use in mid-war but were the most useful invention of the first decade of practical flying. (*S. Millar.*)

2

Service trials of the Royal Aircraft Factory's S.E.5 had proved pleasantly satisfactory in the hands of Lieut Roderic M. Hill and Lieut F. H. B. Selous of No. 60 Squadron which was equipped with Capt Albert Ball's favourite – the Nieuport. Hill's report was less biased than Ball's: 'The S.E.5 has in my opinion certain advantages over the Nieuport and Spad. Its speed is good; it involves little strain on the pilot; it climbs as slowly as the Nieuport and slower than a Spad; it is stronger than a Spad; its gun mountings are superior. Its disadvantage with respect to the Nieuport is that it cannot be manoeuvred with quite the same rapidity although at high altitudes manoeuvres should be possible with much smaller loss of height.' Various modifications and refinements were made to A.4562 while it was at St Omer, and on 4 January it was flown back to Farnborough by Selous.

Frank Goodden flew it briefly on the 26th, and then on a frosty Sunday two days later he took off from Farnborough Common for a longer flight, but after eight minutes was seen heading towards the airfield at about 1,000 ft. Then disaster. Unofficial reports stated he was looping when one of the wings broke away just as he reached the top, and the machine crashed to the ground, causing the instant death of Goodden. Eye-witnesses agreed that the interplane struts on one side fell out, but the Committee of Enquiry set up by the Royal Aircraft Factory decided that the propeller had burst and the out-of-balance forces caused the wings to collapse.

Maxim's earlier technical assistant, Capt A. P. Thurston, had for the past year been head of the Military Aeronautics Directorate's Design Safety Standards Department, under General McInnes, RE, who was in

charge of Technical Direction of the RFC. Recently they had been statically testing to destruction every type of aeroplane selected for operational use. Committee of Enquiry reports of mechanical failures to aircraft were meticulously studied, and Thurston found that their conclusions often were not justified owing to technical misapprehension. Typical were half a dozen cases where the B.E.2e's long top overhangs had failed, usually when diving, and the official finding was that they had collapsed upwards, with recommendation that tension wires should be added along the triangular pylon struts supporting the overhang landing wires. Thurston found that instead of tension failures, the struts collapsed in compression – and this led to reconsideration of strength factors required under down-load.

Frank Goodden and his S.E.5 prototype on Farnborough's rough-surfaced aerodrome. The pilot sat high behind a long slanting windscreen. Later, side wings were added to the windscreen, and the exhaust altered to rear ejection. (*Imperial War Museum.*)

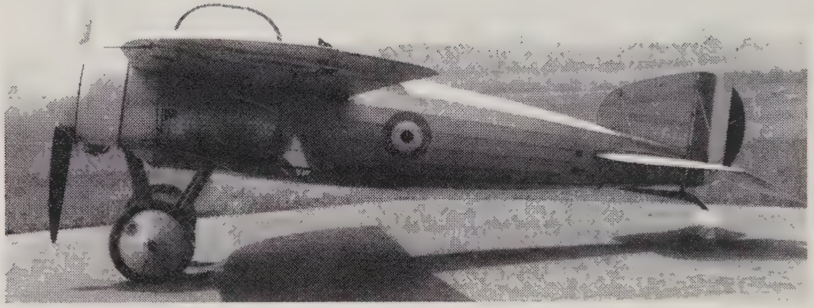
'One of the most successful machines of the war was the S.E.5,' he wrote. 'This was conceived, and the design started, by the chief test pilot of the Royal Aircraft Factory, Major Frank Goodden. Two prototypes were built and flown. When A.4562 collapsed in the air after some 20 hours flying, I ordered a guard to be placed upon the wreck and the area to be searched and the pieces of propeller found and fitted together. The whole of the periphery of the propeller was recovered and assembled, and it was obvious that the wing fracture was not due to the propeller. Instead I found that one bottom spar had failed by downward torsion under reversal of load such as inverted flight. This could not have happened unless something else failed first in the interior of the wing. I therefore visited the first prototype, which had been flown nine hours, and gave the bottom wing a bang. There was a nasty jarring from the interior bracings showing

they were slack. I therefore stripped the fabric with my penknife, and incipient lines of failure could be seen in the varnish of the strengthened ribs taking compression between the wing struts. In effect they were like a box without a bottom, with no provision to resist torsion due to download on the front of the wings. Consequent distortion allowed the strut pin to slide free from its fork-end attachment to the spar, so I recommended that a piece of three-ply be placed between upper and bottom flanges from front to back spars to make a box and take the torsion. This was done and subsequently many of these very fine machines were made and flown without further trouble.' Meanwhile the jury returned a verdict of Death by Accident – for culpability in technical design is rarely established.

Although only 26, Frank Widdenham Goodden was regarded as an old-timer, for he had been active in aviation ever since leaving school, and in 1912 built a splendid Antoinette-like monoplane at his home at Wolvercote, Oxford. Tall, handsome, technically knowledgeable, and possessing that charm and vividness of spirit which lends itself to leadership, his passing left a blank. Nobody currently had the same extensive testing experience.

But what was one life compared with the carnage of the battle-front? On 31 January the German Government decided to carry war to greater extremes, notifying neutral countries that unrestricted submarine warfare would be waged if ships entered a wide area of barred zone where every vessel would be sunk without warning. No step could more greatly antagonize the USA, for agreement had earlier been made that merchantmen would not be sunk unless passengers and crew were first enabled to leave the ship. But the Germans were implacable: in the submarine they had a more developed weapon than any other country. Already the U-boat *Deutschland* had astounded the world by crossing the Atlantic and sensationally surfacing in New York harbour. With such range and ability to remain submerged, this determination to torpedo without warning made it abundantly clear that England might well be defeated through starvation.

To counteract such possibility the tempo must be speeded. There must be more and more guns and shells; more people trained. Every branch of scientific knowledge must be co-ordinated. As a step in this direction, the Society of British Aircraft Constructors and the Aeronautical Society of Great Britain agreed close co-operation in their respective spheres, establishing a standing committee of equal numbers of the Council of each Society to consider questions of general policy, and a technical committee to investigate problems such as standardization. Both would deliberate with government departments, particularly with the new committee of the Privy Council which had been instituted to develop and link scientific and industrial research. Behind the resurgence of the Aeronautical Society was Handley Page once more. Under his dominating influence a splendid programme of lectures had been arranged for 1917, boldly initiated with a Paper of his own authorship entitled *The Case for the Big Aeroplane*, to be followed by later lecturers such as E. F. Relf of the NPL, on *The Aerofoil and Fluid Flow round Bodies*; his colleague A. Fage, on *The Air Screw*;



No contemporary fighter was cleaner than the Bristol Monoplane Scout which had single-bay bracing. This prototype had the original cabane comprising two half hoops of steel tube. Spinner suitability and engine cooling had been tested on Bristol Scout No. 5555. (*Bristol Aeroplane Co.*)

Capt F. S. Barnwell of Bristols with *The Modern Aeroplane*; L. Bairstow of the NPL, on *Stability and Control*.

Said Handley Page, lecturing with his usual adroit salesmanship: 'The question of aeroplane size is a most important one. It raises the whole question as to whether there is limitation, and therefore whether progress in construction will be limited to improvement on present small types or whether there is infinite possibility in extension of design to much larger aircraft.'

Not unnaturally the argument showed everything in favour of his own large multi-engined aeroplane, the O/100, which H.P. illustrated with lantern slides, commenting that it carried a useful load of several tons, though so far it had only lifted 21 people at a time. Said C. G. Grey: 'One would enjoin on Mr Page not to be disheartened on that account, as doubtless he will in due course produce an aeroplane which will carry 50 people in comfort.'

Although the meeting of aeronautical experts was generally somewhat sceptical of H.P.'s arguments they could not disregard the evidence of his success with the O/100. As proof of his own conviction, Handley Page had completed a great new factory at Cricklewood, not far from the Riding School where his earlier machines were constructed, and the flat, open fields to the west were having their hedges grubbed out so that testing could be conducted at his own grass aerodrome. Recently he had appointed as general manager of the company, R. S. Hubbard, who was already well known in the North as manager of the Aviation Department of Beardmore though his major experience had been with shipbuilding companies in Scotland, USA, the Netherlands and Japan. H.P. saw rising production, but he was not merely a hard businessman: there was a kindly side to his shrewdness, and it satisfied both aspects to establish early in the war a mess room which undertook to provide a mid-day meal at 6½d a head whether the firm lost thereby or not – but at least it retained the men as his vital tools. Next to aviation he devoted more time and energy to technological

education than to anything else. 'There is no lack of bright original ideas, nor of people with them in Britain to-day,' he wrote. 'The more alert companies and research establishments provide ample encouragement and resources for realizing many native ideas and inventions.' Again this interest had dual purpose; yet above all he was already a figure of rugged independence, with complete trust in his own ability.

Such was the vital importance of aircraft production that early in February William Weir was knighted in acknowledgment of his great organizing ability. The first obvious sign of his Air Board activities followed with the appointment of Arthur E. Turner, who had been responsible for aircraft purchase at the War Office, as Director of Aircraft Contracts. He was a man strictly combining absolutely honest business methods with fairness in considering a contractor's financial arguments, and although regarded as hard, was held in high esteem. In ones and twos, disabled men discharged from the Services were finding jobs in aircraft and munition factories. The Government had accepted responsibility for disability pensions and training in new trades the thousands handicapped by wounds or gas attacks. One of the effects, and perhaps the only good one, arising from the war was the tremendous advance in medicine and surgery, so that attention was being paid not only to recovery from wounds but to use of plastic surgery, and the skill of brain and nerve specialists was given to those suffering from the new phenomena of 'shell-shock' or to rehabilitation of the blinded.

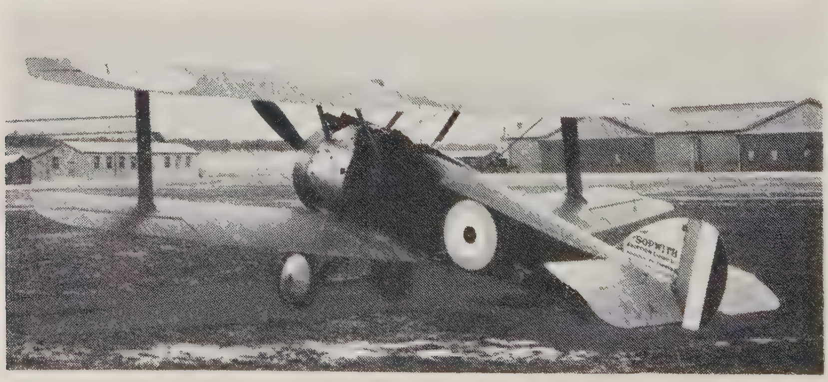
At the end of February came unexpected news of German retreat from Arras to Soissons. Everyone was enormously encouraged. Yet the Allies were unable to take advantage by swift occupation of the narrow strip of country. All the Germans had really done was retire to the Hindenburg Line which they had been effectively fortifying during the winter stalemate, shortening their defences by 40 miles. After his great and successful campaign on the Eastern Front, Hindenburg had virtually become Commander-in-Chief of the German forces on the Western Front, and the strategic retreat was his first great operation. Disappointment at Allied inability to inflict profound defeat while the Germans were on the run almost immediately gave place to new hope at news that the Canadians had made a great assault, capturing the slight but commanding position of Vimy Ridge together with 20,000 prisoners and 250 guns.

Throughout those first two months of the year there had been much flying with the new Sopwith F.1. Almost immediately followed the F.1/1 variant, characterized by single **I**-struts each side, similar to the triplanes, with tapered wings which brought the spars closer at the tip, shortening the strut attachment cross-bar and reducing bending. Because this seemed so clean a machine, comparative trials had great urgency but revealed little difference in performance. As the parallel-spar system required less constructional skill it was established for production, and modifications such as improvement to upward view, using a trailing-edge cut-out and centre-section transparent panels, were incorporated in the next development

The Sopwith F.1/2 Camel prototype which differed from the F.1 in having the side cowling faired elliptically into the fuselage, and had a windscreen and centre-section panel cut out. (*Fleet Air Arm Museum.*)

machine. By the end of February a fully modified version known as the F.1/3 was ready as production standard for official trials at the RFC Testing Squadron newly transferred from Upavon to Martlesham Heath near Ipswich.

Almost immediately it was christened the Camel because, as Sir Henry Tizard told me: 'I was the technical officer in charge at that time, and one of the pilots on seeing the new machine apprehensively exclaimed "Just to look at the beast gives me the hump at the thought of flying it!" – though its name is more usually connected with the humped fairing over the twin gun breeches.' Like the soubriquet Pup, the nickname spread like wildfire, but from the beginning the machine had a very mixed reception. It was



At Brooklands, the prototype F.1/1 Camel with tapered wings and I-struts looks aerodynamically cleaner but disappointingly gave no greater speed than the more conventional F.1 and landed faster. (*Fleet Air Arm Museum.*)

hated or loved. 'Here was a buzzing hornet,' Norman Macmillan later wrote, 'a wild thing, burning the air like raw spirit fires the throat.'*

Major Geoffrey Moore, DSC, the Navy's CO at Eastchurch, described the Camel as unstable in all directions and particularly sensitive fore and aft. Because it was much influenced by engine torque he considered it a death-trap to the inexperienced, though a skilled pilot could not wish for a better mount. Camels were wonderful in a dog-fight because they could make the quickest change of direction of any: all that was needed was to pull up the nose, cut the engine, and stall turn augmented by aileron, rudder, and elevators, when the machine would flick round, particularly to the left.

The F.1/3, at Martlesham Heath in March 1917, had a 130 hp Clerget 9B, and though still with one-piece upper wing and short ailerons was regarded as the production prototype. (*A. R. Boeree.*)

The S.E.5 was very different. In No. 60 Squadron, which had Nieuport Scouts, was a rising young Canadian pilot, Lieut William Avery Bishop, who later that year flew the S.E.5 with which his squadron was being re-equipped. Like that other Nieuport pilot, Capt Ball, he was not very impressed with the Factory-designed machine, finding it heavy and awkward after the small Nieuports, and landing at higher speed.

A decade later I flew an S.E.5 and found it very like a Moth, though lateral control became much heavier with speed – until in a dive of 140 mph brute force was necessary, giving the impression of sluggish response although in fact proportional to the amount of aileron applied. To apply them abruptly would have outraged one's flying intuition, so I can see that the relatively sensitive Nieuport would make the S.E.5 seem at a bad disadvantage in evasive tactics with a Hun on the tail. In other respects it was delightful: firm in normal behaviour owing to the general stability which made it a good gun platform, and directionally kept true in a dive with little change of rudder trim between slow speed and high. Even the adverse yaw produced by the downward-moving aileron was a mild virtue

**Into the Blue.*

as it required noticeable rudder to counteract it, and still more to make the turn, so was easier for a heavy-footed pilot than the Camel's tendency to swing instantly into a turn if directional trim pressure was momentarily released. The Camel was worse than the S.E.5 at the stall because of incidence wash-out on one wing to counteract the lifting effect due to torque; whereas the S.E.5 was rigged symmetrically, giving an innocuous stall at little over 40 mph on pulling the control fully back, the nose dropping briefly, and one or other wing lightly nodding down. But the Camel would flick into a spin.

Few of the thousands of war pilots ever analytically studied control behaviour. Whether flying bomber, fighter, or seaplane, there seemed no more to it than that the machine either responded to their instinctive senses, making smooth sweet turns, or felt as though it had a will of its own and skidded and swung with ugly intent. Thus Bishop, who was no artistic pilot though deadly with his gun, described flying the R.E.7 as: 'When a pilot wants to change direction he has to *throw* the stick in the direction he wants to go – really slam it. Putting on rudder was done about as gently as throwing out the clutch of an automobile. The thing was nearly as manoeuvrable as a ten-ton truck, but by no means as safe.'* But in the heat of the fight, classic flying was thrown to the winds. Fierce sudden stabs on rudder and stick were used to keep gun-sights on the jerking, swaying target. The more inaccurately one flew, side-slipping and yawing, when the

* *The Courage of the Early Morning* by W. Arthur Bishop.

The hump of the Camel contained its fire power, and the gun butts were within reach for clearing stoppages. Landing view was good for a single-seater but the centre-section was an obstruction to vision when diving. (*A. R. Boeree.*)

Ungainly the R.E.7 looked, and heavy to handle it certainly was, but throughout 1916 its ability to lift a 336 lb bomb made it of considerable offensive value. It survived operationally in the Middle East, but at home a few continued in service only for training and towing aerial gunnery targets. (*D. F. Woodford.*)

enemy was trying to get his bead on you, the more difficult for him to align accurately for the fatal shot.

At the hands of Martlesham pilots the S.E.5 received a discouraging report: 'Lateral control insufficient, especially poor at low speeds; hence the machine manoeuvred poorly, and was almost uncontrollable below 70 mph, gusts causing a crash on getting off on 29/3/17. Suggested that aileron control be geared higher. Time for complete turn of 360 degrees, 12 seconds.'

To improve matters the rear spar overhang was reduced in length, moderating the marked rake of the wing-tips and shortening the span to 26 ft 7½ in; but the batch of 24 under construction at the Royal Aircraft Factory were modified no further than Thurston's recommendations.

3

Following the successful Bristol Fighter, the prototype D.H.4 with 230 hp BHP had recently been tested at Upavon by the Testing Establishment pilots, who reported: 'Lateral stability very good: longitudinal very good: directional very good. Length of run to unstick, 150 yards; to pull up 120 yards. The machine is exceptionally comfortable to fly and very easy to land. Exceptionally light on controls. Tail adjusting gear enables pilot to fly or glide at any desired speed without effort.' The second prototype had followed, fitted with the 250 hp Rolls-Royce, and earned similar commendation, though it was found more nose-heavy on the glide.

Such was the intensity of approval flying of new types that the development work of the Armament Experimental Flight had just been transferred to Orfordness on the empty sand-dunes of the Suffolk coast. As seaplane and flying-boat test work was concentrated nearby at Felixstowe it seemed

sensible to bring landplane testing to the same locality, particularly as this would ease the problem of aircraft availability for bombing experiments. It marked the scientific influence of Professor Bertram Hopkinson, now a Major RE, who had been Busk's tutor at Cambridge in the Chair of Mechanism and Applied Mechanics. Appointed in July 1915 to the panel of Lord Fisher's Board of Inventions and Research, his particular responsibility had been bombs and guns at the Department of Military Aeronautics. This brought him in contact at Upavon with the energetic and penetrating Tizard and his principles of aircraft performance measurement. Hopkinson and Tizard had made temporary headquarters at the White Hart at Ipswich in order to search for a site. Driving to Orfordness took them past the great heather-and-ling expanse of Martlesham Heath and its avenue of pine trees from east to west. Here was ideal ground, though too beautiful to be despoiled by war, broad and level, convenient to the other two establishments, with the pleasures of Ipswich and the facility of its train service thrown in. So it was commandeered from its owner Capt Pretyman, MP. The ancient trees were felled and humps removed from the dry peaty surface. Three hangars were erected alongside the road running across the heath, and a large wooden bungalow was built as the Mess. Lieut-Col H. L. Cooper was appointed Commandant, and Capt Tizard was established as technical officer in a small separate office. The best-loved aeroplane testing establishment in Britain had opened business.

Some of the test pilots of the Aircraft Experimental Establishment at Martlesham Heath. Beginning second from left are Capt Carr, Maj Cooper, Col Hopkinson, Capt Tizard and Lieut Saint, RN. (*G. Kinsey.*)

Complementing activities at Farnborough, Martlesham, Felixstowe, and the Naval establishments at Eastchurch and Isle of Grain, a new and important School of Special Flying was initiated at the small aerodrome of Gosport, near Portsmouth, under command of one of military aviation's most remarkable characters – Major Robert Smith-Barry.

In 1912 he had been one of the earliest pupils at CFS and was commissioned Second Lieutenant RFC Special Reserve. Despite severe injuries at the beginning of the war in the crash of a B.E.8 through engine failure, resulting in a limp for the rest of his days, he returned to active flying on the Western Front. Convinced that youngsters were sent from England half-trained as 'Fokker fodder', he began pressing for changes in the whole system of flying tuition. In a letter dated 10 December, 1916, he had written to Headquarters: 'Up to the end of last May, when the writer left England, no attention whatever was paid to the fundamental importance of instruction in the mere manual part of flying. This was left to those who were resting, those who were preparing to go overseas, and those who had shown themselves useless for anything else. The first two classes had other interests paramount; the third had no interests at all. The present-day pupil is being taught to fly by people who are altogether without enthusiasm, and whose indifference is, as always, contagious.

'It is submitted that a good way to remedy this would be a school of training for instructors, where they could (*a*) have their flying brought up to the very high standard necessary before they can teach with confidence and ease, and be combed out if they do not speedily reach this standard; and (*b*) be given definite lines upon which to instruct. The institution of such a school would tend to produce an *esprit de corps* among the instructors and could improve the atmosphere surrounding the whole business.

'The writer has been surprised to notice how little interest in flying is taken by many young pilots who come out to the Front. Though very young, and quite fresh, they have to be ordered to go up from the very first; they never ask permission to go up even for a practice flight. Before the war young flyers were always begging to be allowed up. It is thought that this, though in part due to the difference between voluntary and impressed labour, is largely due to the mental supineness of instructors in England.'

The Officer-in-Command of the Training Division was General John Salmond, who had been an instructor at CFS while Smith-Barry was a pupil there and had the highest opinion of this fiery fighting pilot. Convinced that Smith-Barry's views were sound, he re-posted him at the end of 1916 to Gosport, in command of No. 1 Reserve Squadron, with a free hand to test his theory.

The long-established Avro 504 now finally found its place. One of Smith-Barry's tenets was that instructors had hitherto played safe, taking the customary rear-seat piloting position of dual-control machines. He now ordered instructors to occupy the front, in the mode set by the 1½-Strutter and followed by the Bristol F.2A, D.H.4 and the R.E.8, and pupils

would use the rear cockpit for dual and solo alike. Every possible flight manoeuvre would be taught whatever the weather, going far beyond the scope of previous instruction because 'the mere capacity to leave the ground and land in safety does not qualify a pilot for scout or artillery work'.

As John W. R. Taylor commented in his history of CFS: 'At that time the idea of using a 504J for *ab initio* training was revolutionary. It had a 100 hp Gnome Monosoupape, and pupils normally graduated on to it after several hours on Farmans. Nevertheless Smith-Barry knew what he was doing. He wanted a trainer that would teach pupils to fly combat aeroplanes and the 504J had every qualification. The controls were light and powerful, it could perform all aerobatics then known, and its engine taught pupils from the start to watch out for the torque effect inevitable with a comparatively large rapidly turning rotary engine. They learned to correct any tendency to swing or drop a wing during take-off – the narrow undercarriage track emphasized this – and how to control a forced landing with the engine still turning. Nor was it necessary any longer for instructor and pupil to communicate only by stick-wagging and hand-waving. Before long an elementary but effective one-way "telephone" system had been fitted to all aircraft, consisting of a pliable tube with ear-pieces for the pupil at one end and a funnel-shaped mouth-piece at the other end. With this, the instructor could explain exactly what was happening or about to happen at any moment, ensuring that the pupil understood the precise action of the controls in everything he did, from his first circuit and bumps right through to spinning and aerobatics. The latter had never been taught previously, and the natural result was that Gosport pupils finished up masters of their craft, ready to join any Service squadron and fight with confidence in the knowledge that, whatever position they found themselves in during a dog-fight, they had been shown how to get out of it.'

That air warfare would require the finest pilots and aircraft to meet mounting opposition of the German Air Force was a matter of increasing

Morning line-up of Mono-Avro 504Js for *ab initio* instruction by Smith-Barry's method of dual-control demonstration and explanation which revolutionized pilot training from 1917 onwards. (*D. F. Woodford.*)

concern. On 5 March the Germans tried out their new twin-engined Gotha bombers with a raid on the British forces at Salonika. Two were brought down, but it did not deter the German plan of moving the squadron bodily to Flanders with intention of attacking England. Everywhere along the Western Front there was renewed activity by German aeroplanes, including many new types, which were put into the air in great numbers to prevent the RFC keeping track of the German Army's movements. In the House Sir H. Dalziel, MP for Kirkcaldy, asked Mr Macpherson, Under-Secretary of State for War, whether he could assure the House that we still maintained mastery of the air on the Western Front. 'I think I can give that assurance,' he replied amid cries of 'Oh! Oh!' It was evident that the feeling of the House would lead to new agitation over the air war. Significantly Joynson-Hicks was elected that day as chairman of the newly constituted Parliamentry Air Committee – regarded as a non-political, non-party body of members of both Houses so that all air matters could be fully probed.

A few days later news came that Cavalry-General Count Ferdinand von Zeppelin had died in his 79th year from pneumonia on the morning of 8 March at Charlottenburg. From the time his first airship took the air on 1 July, 1900, a great succession of unique, if unhandy vessels followed, and in these early years of this great European conflict, Germany scored heavily through monopoly of their use both as scouts for Fleet actions as at Jutland, and aerial invasions of Great Britain which dangerously affected the output of munitions of war. Certainly during the latter part of 1916 all airship raids had met with heavy losses, and since the one on the night of 27/28 November, when two were destroyed, a strangely long period had elapsed during which it was assumed the enemy were building still more airships. None could imagine it was to be the last; but the Germans had realized that the return for expenditure on Zeppelins was incommensurate with their effect on the war effort. Only the first raid over London by a seaplane the following night could have given a clue.

In the fog of war the British people seemed less hopeful than the Germans at this stage. Widespread concern had been caused by news of a great revolution in Russia. On 15 March it was reported that the Czar of all Russias, Nicholas II, had abdicated in favour of the Grand Duke Michael. There were stories of a monk called Rasputin who had been murdered at a dinner party in Petrograd because of his evil influence on the Czar and Court. Everywhere in Russia there was dishonesty and incompetence, their army maladministered and without weapons of war and sufficient food. They had reached the limit of endurance; all confidence, all hope, was lost. The Russians were sick of the old autocratic order and unendurable miseries. For a time it seemed that a controlled revolution might be possible, but the people's picturesque leader, Kerensky, was too moderate to hold the mounting tide. He was cold-shouldered by Allied Governments; pressured by a body named the Soviet which had arisen in Petrograd to represent the workers and common soldiers. In the absence

of Western support it seemed he could hold control only for a limited period.

In England there were serious but more moderate threats. The British Government faced acute trouble between 21 March and 4 April, for a strike of engineers at Barrow led to defiance of trade union officials and the Ministry of Labour. Nothing but threat of drastic use of DORA and conscription brought it to an end. Indeed, there was reality to the threat, for the British Army had obtained a mere 100,000 recruits since the beginning of the year, and this was leading to harsher action by tribunals, who were imprisoning conscientious objectors.

On 6 April banner headlines in the evening papers announced that the United States of America had declared war on Germany. Impact of this news attained a slight theatrical quality because on the following day America's impoverished relation, Cuba, also declared war on Germany. People generally were sceptical of the USA's intentions, feeling that nation's very remoteness rendered active war participation too difficult, so the chief effect could only be a moral one. But in fact that great country had been steadily preparing these many months – though their techniques were studded with anachronisms.

4

Vickers, Avro, Blackburn, Airco, Armstrong, Sopwith, Martinsyde, Short, indeed many newcomers as well, were not only steadily expanding their quantity construction of the newest operational aeroplanes, as well as some which were outmoded, but, like the Aircraft Manufacturing Company and British and Colonial, were designing the particular type of fighter, bomber, reconnaissance machine, or seaplane which seemed suited to their individual experience. Several of the pioneer draughtsmen were now chief designers of the newcomers; others were transferring their allegiance from

Harry Tate was the soubriquet for the R.E.8, of which more than 4,000 were built by nine factories between 1916 and 1918 and used in greater numbers than any other, rendering vital service to the British artillery. (*Flight Photo.*)

Eventually a large fin was standardized on R.E.8s. It is seen here being tried on Napier-built A3902 at Farnborough.

the Royal Aircraft Factory to commercial companies where they would work for greater salaries. Leading these was Major F. M. Green, the chief engineer. In January he secured appointment as chief engineer to the Aviation Division of Siddeley-Deasy Motor Car Co Ltd of Parkside, Coventry. With him he took his engine designer S. D. Heron who had played a big part in the design of a two-row fourteen-cylinder radial air-cooled engine known as the RAF 8. They were joined by J. Lloyd, who had been in charge of a section designing the R.E.9, a two-bay equi-span biplane intended as an R.E.8 replacement. Ever since its operational initiation with No. 52 Squadron in November 1916, the R.E.8 had been unfairly condemned as having dangerous flying characteristics. The old fear that its long top wing overhangs would collapse had never been quite overcome. Progressive changes with bigger fins not only confirmed to squadrons the uncertainty of directional stability and spinning characteristics, but indicated difference of opinion within the Royal Aircraft Factory because the machine was originally designed with an excessively large top fin which was changed for a small one. Eventually top and bottom fin areas were standardized with only slight increase, but new recruits still suffered casualties from the readiness with which the R.E.8 spun if bank was held off during a gliding turn. One R.E.8 pilot, Lieut A. H. S. Lawson, RNAS, who flew them at Eastchurch School of Gunnery, said: 'They had the feel of manoeuvring a cubic foot of solid lead pivoted high using a pencil for a joystick – though they were far superior to the pushers we had been flying which were composed of parts from Horace, Maurice and Henry Farmans. Presently the Admiralty relented, and we were given Bristol Fighters which were sweet indeed.'

Major J. A. Chamier, DSO, at Corps Wing Headquarters went a long way to re-establishing morale by flying one of the R.E.8s of No. 34 Squadron – which previously under his command had flown B.E.2es – in order to discuss problems personally with the pilots. As a result he issued what

amounted to practically the first set of Pilot's Handling Notes, of which J. M. Bruce has made the following extracts:*

'This is a splendid flying machine but it is not a perambulator and requires at first a little care. The chief thing to remember is that the R.E.8 gives very little indication of losing speed until it suddenly shows an uncontrollable tendency to dive, which cannot be corrected in time if near the ground.

'All the recent accidents in R.E.8s can be equally divided into two classes:

'(a) With engine pulling, the machine will not stall at 50 mph but it is not advisable to allow the speed to get so low. The only accident likely to occur with engine on is spinning, or more correctly swinging tail. This is caused by having too little bank for the amount of rudder used. It can be stopped immediately by increasing bank and taking off the rudder – you will find the rudder control in every case of spinning or swinging tail will become very stiff, and you may not be able to get it very central but you should aim (without putting on sufficient pressure to break anything) to do this.

'(b) With engine off the only thing to avoid is gliding too slowly. I have already said that with the engine on the machine will not stall at 50 mph – but when gliding at 65 mph or below, the machine suddenly loses speed. This is particularly the case when making a turn to enter the aerodrome as extra resistance caused by the rudder is sufficient to bring down the pace.

'One more point as regards losing speed. Observers must be cautioned that when an aeroplane is gliding down from work over the lines they must not stand up in order to look over the pilot's shoulder for the fun of the

*_Profile 85_, _The R.E.8_ by J. M. Bruce.

Conversion of an R.E.8, No. A4600, built by Standard Motor Co Ltd to R.E.9 was made by fitting smaller span two-bay wings of similar total area, but performance proved inferior owing to greater drag. (_Courtesy The Royal Aeronautical Society._)

thing, as the extra head resistance caused may lead to the aeroplane falling below its critical gliding speed, and so bring about an accident.'

Concurrently R.E.8 contracts were widely placed with Siddeley-Deasy and other major motor companies who had saw-mills and workshops equipped for the standard woodwork frame-making of car bodies. By the middle of the year it was estimated that well over 800 'Harry Tates' * would be delivered, and the ultimate target was estimated in thousands. Meanwhile the Royal Aircraft Factory was following its usual procedure of making a replacement, the R.E.9, largely from the standard parts and components of the existing R.E.8, still using the same chord and stagger as the B.E.2s, but reducing the gap nine inches. Farnborough design, like Sopwith, was a jig-saw puzzle using variation after variation of the same theme in broad conception and detail. It was while this revamped R.E.8 was still under construction that Green had departed for Siddeley-Deasy, taking with him the comprehensive know-how he had initiated on every aspect of Farnborough's design work, whether engines or aircraft, including the latest S.E. proposals for the more powerful S.E.5a, and a new S.E.5b with bigger wings of unequal span and chord and outwardly raked interplane struts to give similar lengths of overhang top and bottom.

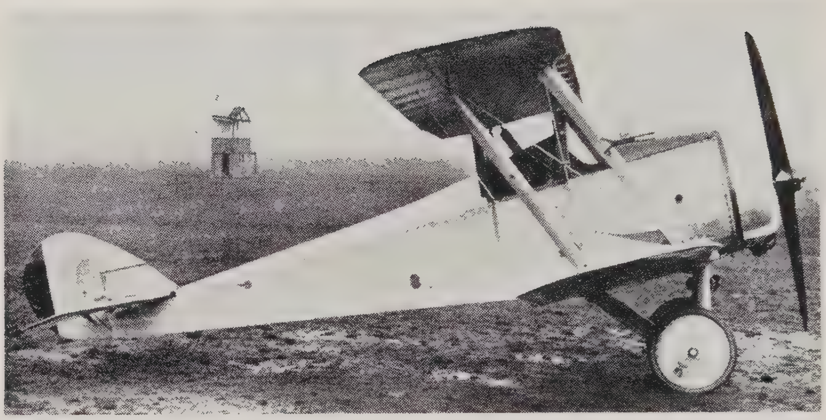
Henry Folland, the man responsible for design of the S.E.5 series, also left Farnborough, joining the Nieuport and General Aircraft Co Ltd, of Cricklewood, one of the group of firms founded by Samuel Waring of Waring and Gillow. With him went Major S. Heckstall-Smith who had been assistant superintendent at Farnborough under O'Gorman, and he was joined by L. Hall, works manager of the Mechanical Engineering Department. Soon they were followed by H. E. Preston, who had been Folland's leading draughtsman at Farnborough. Design work began with further consideration of a machine similar to the S.E.5b, but it was a gamble whether to incorporate S.E.5 components with which they were so familiar, or those of the Camel for which the company had developed considerable and successful production.

Green and his two assistants were equally quick off the mark, and as soon as they had organized their respective offices and work, Lloyd and a handful of draughtsmen commenced major design modification of one of the R.E.8s under construction in the Siddeley-Deasy shops, intending to compete with the R.E.9 using two-bay wings having greater chord to the top wing than the lower, like the S.E.5b. Concurrently, under Green's direction, Heron and the Siddeley-Deasy engine designers began work on a radial engine which amounted to completion of the RAF 8 drawings.

At this period the newly standardized types such as the D.H.4, Bristol Fighter, the S.E.5, the Camel now in big production, and even the Avro 504, all had equivalents hopefully produced by rival designers of other companies.

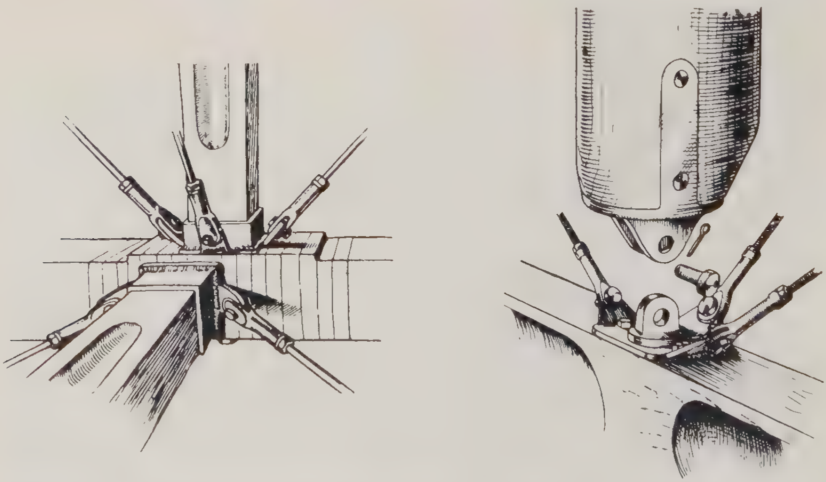
Thus Geoffrey de Havilland, like so many pilots, had appreciated to the full the attractions of the Sopwith Pup, and had proceeded to work his

*Contemporary rhyming slang for the R.E.8.



The prototype D.H.5 at Hendon reveals pre-war race starter's tower in background. De Havilland used flat fabric-covered sides abruptly faired with stringers into the circular nose. View was superb, and lateral control outstanding, but the original fin and rudder proved too small. (*Courtesy F. E. N. St Barbe.*)

sketches of an equivalent tractor rotary-engined fighter into a cleverly arranged design affording the same splendid fighting view as his pusher D.H.2 by giving the wings pronounced backward stagger and placing the pilot with his head below the leading edge of the top wing. In one brilliant move he eliminated the old bogy of the blind area caused by the wings which could hide the target when viewed from the customary aft cockpit location – but everything is compromise, and many pilots were now worried that hostile aircraft would creep unobserved above and behind them. Criticism



Well engineered simple fittings were part of C. C. Walker's big contribution to de Havilland design: fuselage spacer joint (left) and interplane strut to spar (right). (*Courtesy H. Busteed.*)

that this front-seating would render the pilot more susceptible to injury in a nose-over was foreseen by de H., who made the fore structure particularly rigid with plywood reinforcement of struts and longerons, in similar manner to the Martinsydes and his D.H.3 and D.H.4, but to save every ounce of weight the plywood was key-sawn into lightening holes between adjacent structural members. After enlarging the fin and rudder, Service trials in December led to a precautionary production order – for there was no knowing whether the new Camel would prove too difficult for squadron pilots, and the much more stable D.H.5 would therefore form a useful stand-by as it was more conventional in reaction yet was so responsive to its ailerons that it had equal ability to turn quickly.

By now the lineage of a de Havilland machine was unmistakable, for he had standardized his methods of construction, whether of spar shape, streamline strut, or fitting, with an individual D.H. impress; but no less distinctive were the very different fittings of a Folland-designed machine, a Hawker-Sigrist, or the characteristic fittings designed by Volkert for Handley Page.

Uncompromisingly angular except for its graceful de Havilland rudder, the prototype D.H.6 had a rugged simplicity and very high drag. An order for 200 was immediately placed with Grahame-White and 500 with Airco. Various firms shared a further 2,000. (*Airco.*)

Even in the relatively crude D.H.6 trainer which was the next production of the Aircraft Manufacturing Company, these characteristics could be discerned, despite uncompromising squared tips, vertical interplane struts, and blunt, unfaired nose. It was visible expression of the need for more and more pilots to be trained. One school of thought in the RFC believed the Avro 504 too perfect in response for ham-fisted pupils, and it was generally felt that something cruder and more robust would do, particularly if it could be built by unskilled labour. The Martinsyde trainer and Fletcher's London & Provincial, having failed to meet the mark, the Air Board had given Grahame-White Aviation, Ruffy, Arnell &

Baumann Aviation, and the Aircraft Manufacturing Company, opportunity of designing to the same requirement, and each produced similar machines. The G-W was the second design essay of Grahame-White's new chief designer H. V. Hedderwick, who had succeeded J. D. North, under whom he had gained early experience leading to the big G-W Type 18 bomber.

The D.H.6 was clearly the more sophisticated of the three trainer designs and was selected, but as consolation the Ruffy-Baumann concern received a training contract. Grahame-White was given the opening contract for de Havilland's 'Clutching Hand', as the D.H.6 was quickly named by the facetious RFC because of the heavily-cambered wing-section and exaggerated concavity of its under surface, resulting in both high lift and high drag but with enviable ability to stagger along at very low stalling speed.

The Ruffy-Baumann Elementary Trainer designed by J. A. Peters late of Robey and Co. (*Jane's All the World's Aircraft.*)

Almost immediately Grahame-White Aviation were in trouble. They had been building Breguets and Moranes, for which they held the British licence, though the great stand-by was the Avro 504. Over 1,000 men and women were employed compared with 20 at the beginning of the war. There had been such bickering between Grahame-White and the Air Department ever since his release from the RNAS, as Flight Commander, for full-time aircraft production. His uncle, Francis Willey, backed him by guaranteeing an overdraft of £50,000. Despite pre-war acclaim as the great air hero of the day, Grahame-White was unspoiled, J. D. North assured me, though essentially individualist and resenting the red tape imposed by Government departments. He knew he was technically sounder than the new recruits to bureaucracy.

With January came his great order for 700 D.H.6s, but it was the beginning of increasingly bitter controversy with the Air Board. In his biography of Claude Grahame-White,* Graham Wallace wrote: 'The timber mainly employed in the D.H.6, and, indeed, the majority of aeroplanes, was silver spruce from the forests of Oregon in Washington. Light, long-grained, with great strength and resilience, it was ideal for wooden airframes. For

* *Claude Grahame-White* by Graham Wallace (Putnam).

supplies, Britain was wholly dependent on America – but in April 1917 the USA joined the Allies and shipments ceased as stocks of silver spruce were requisitioned for the American aircraft industry. As a substitute the Government supplied Grahame-White and other contractors with swamp cypress, hitherto untried.

'On the first day of its use Grahame-White was summoned urgently to his saw-mills. The foreman showed him some longerons for a D.H.6 just cut from a consignment of swamp cypress. The wood was wet, unseasoned and ominously short-grained. Grahame-White sent a sample to his materials testing laboratory and asked for a report. It confirmed his forebodings; to work to any degree of accuracy in swamp cypress would be impossible, it would warp and shrink overnight. He stopped all production and stormed off to see the timber controller of the Air Board, taking with him the laboratory report and a billet of the offending wood. The controller brushed aside the report with a curt "I'm not interested in your opinion. When I need advice, I'll ask for it!", and hinted that Grahame-White's place was at Hendon producing aeroplanes and not worrying busy officials in Whitehall.'

The Grahame-White trainer, like the Ruffy-Baumann, was an unsuccessful competitor of the D.H.6.

Long experience of aircraft construction assured Grahame-White that it was murderous folly to use this timber. By registered mail he sent copies of the report to every department concerned with aircraft production, but no action was taken. His hand was forced. Men had to be paid. He could not afford to abandon production; so the swamp cypress was built into the D.H.6s. The completed machines went to the flying schools. From CFS an urgent report was submitted to HQ, RFC, from Lieut-Col A. C. H. Maclean to the effect that D.H.6 airframes splintered on every heavy touch-down. Presently Grahame-White received a cable from the Air Board: 'Stop all work with cypress timber. Condemned by technical department.' Urgently Grahame-White contacted General Alexander,

head of the Air Board Contracts Department: 'I have 100 D.H.6s in the erecting sheds and parts are finished for another 75. Can I take it they will be paid for according to contract even though burnt on your orders?' He was told not to worry about finances, and that a consignment of spruce would be sent within a fortnight, but not until two months had gone did it arrive. By then Grahame-White's overdraft had increased by nearly £250,000.

The Martinsyde F.1 was bigger than the Bristol Fighter, with a span of 44½ ft, but because of observer location in the front seat was already obsolete by the time it flew in the summer of 1917. The top wing had 10 in greater chord than the lower. (*Courtesy The Royal Aeronautical Society.*)

Exasperations of a different kind were hitting Martinsyde. A new version of the single-seat fighter had been built powered with the 275 hp Rolls-Royce Falcon and its R.G. designation has possibly erroneously been assumed to mean Rolls-Royce G instead of Revised G. Tony Fletcher and George Handasyde apparently had become temporarily reconciled, and the result was a most handsome fighter of noticeably greater span than the S.E.5, with empty and laden weights some 300 lb greater, though with fractionally less fuel and oil. Tests presently showed it could beat the S.E. hands-down for speed, with a maximum of 135 mph at ground level compared with 125 mph, and climb to 10,000 ft in 7 min 20 sec against 14 min for the S.E.5 – but the Farnborough design was already allocated for widespread production, and all available Rolls-Royce Falcons were reserved for the Bristol Fighter. A 200 hp S.E.5a version of improved performance was almost ready, so there was no order for the R.G.

By this time Fletcher had again been castigated by the hard driving and often bitter-tongued George Handasyde, and quietly walked out on him, never to return, presently finding new employment with a swiftly expanding woodworking firm at Cricklewood operated by R. G. Cattle which became registered as the Central Aircraft Company.

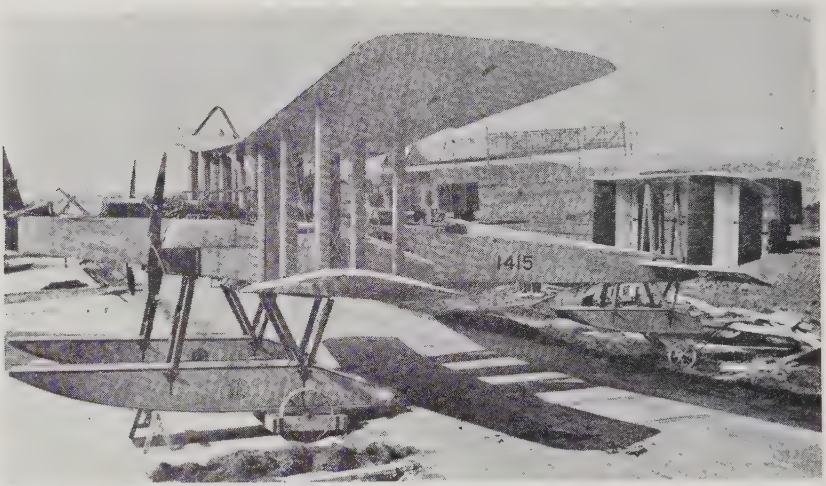
Whether Fletcher had been given the next task of designing a two-seat variant of the successful G.100 Elephant – by scaling-up in customary contemporary manner to give a span of 44 ft 6 in instead of 38 ft, and proportionally increasing other dimensions – is not clear, though it was

An alternative approach to the Bristol Fighter requirement was the compact little Martinsyde F.2 which was as small as the F.1 was overlarge. Poor fighting view was a handicap, but trim would have been impossible with any other crew location.

reminiscent of his earlier work. Influenced by the new Bristol F.2A Fighter, Handasyde decided to set the fuselage similarly in mid gap, leaving the lower centre-section uncovered – though the latter was a poor arrangement aerodynamically because of end losses, as Barnwell soon discovered and rectified by fitting a normal lower centre-section; but the Martinsyde F.1 was even worse than the F.2A because of the large rectangular hole in the top wing centre-section necessary for ingress to the front cockpit. The Martlesham report commented adversely on the seating arrangement: 'The observer is in the front seat, and there is no fixed-gun firing forward. The Testing Squadron suggested it would be a decided improvement if positions of pilot and observer were reversed, while the machine would be better able to resist a strong attack from below. Flying qualities, stability and controllability good; magneto, carburettor, tanks, etc., very inaccessible.'

Handasyde appointed E. Bouillon as chief designer, immediately setting him to work on such major modification of the two-seat F.1 that it became a completely new design, the F.2, with single-bay wings the same span as the R.G. but a foot greater chord, and the pilot under the centre-section slightly forward of the rear spar, with the gunner's cockpit and its Scarff ring close behind. Powered with a 200 hp Hispano-Suiza, it was ready in the spring, when flight trials showed 10 mph greater speed at ground level than the Bristol F.2A Falcon-engined prototype, and very much more than the second prototype F.2A which had only a 150 hp Hispano.

The wind of change was also affecting Blackburns. Harris Booth had left the Admiralty and thrown in his lot with that man of easy friendliness and kindly obstinacy, Robert Blackburn. For some time they had been unofficially collaborating, and now were closely engaged on revising the big General Purpose twin-engined twin-float seaplane designed by Bob Copley which had followed his rotary-engined twin-fuselage T.B. built by Blackburn in 1915 which the RNAS had recently scrapped at Grain. The general geometry of the Blackburn G.P. revealed a scaled-down version of



Characterized by long overhangs to the top wing, the Blackburn general purpose G.P. seaplane was designed as a three-seat patrol bomber and could alternatively carry a torpedo as the pontoons were not interconnected. Like the Handley Page O/100 the wings could be folded.

the successful H.P. O/100, even to the folding wings, though Booth's design features prevailed, and in the S.P. development became even more obvious with scalloped wire trailing edges and ribbed fabric-covered fairing of the interplane struts. Originally multi-powered with the unreliable 225 hp Sunbeam, load-carrying was limited by difficulty of take-off due to inefficiency of the pontoon-like floats, so early in 1917 streamlined and longer floats were designed which, although ascribed to Linton Hope, were probably planked on Harris Booth's patented system with longitudinal joints in staggered relationship. In the attempt to overcome lateral control deficiencies, ailerons were added to the lower wings of the S.P. and two Rolls-Royce Falcons were substituted to give better power/weight ratio for take-off. At this point there was Admiralty reconsideration as to whether floats made an aircraft any safer for flights over water, particularly with multi-engines, or could land-based aircraft be used for anti-submarine work with benefit of 400 lb saved by eliminating the weighty floats? Indicative is the switching of serial numbers from N to B* allotted to Blackburns for construction of twenty land versions designated R.T.1, fitted with rudders of 50 per cent greater area, a revised wing structure, and the new version of the Falcon upgraded to 250 hp.

Retrospectively Robert Blackburn now secured several patents in his own name covering ideas which it had been inexpedient to safeguard in Harris Booth's name while he was a government servant. Thus No. 125,815 back dated 19 April, 1916, is actually in the 1917 series of patent numbers, and describes a system of bracing their novel triplane with lift and landing wires arranged diagonally across the bays between top and bottom wings,

*N serials were naval; A, B, etc., were RFC.

and connected by a cruciform fitting at the point of intersection on the middle wing. Many subsequent patents associated Harris Booth's name with the Blackburn Aeroplane and Motor Co, and some include G. E. Petty, a slender alert-looking young man, with brushed-back fair hair, who had recently been appointed chief draughtsman. Meanwhile the machine had been sent to Eastchurch for assembly and flight trials. Harry Busteed's log book, as Squadron Commander, records:

'10 Jan. 1917. Preliminary tests of Blackburn Triplane.

'15th Jan. Blackburn Triplane – smashed chassis on landing. Machine impossible.'

5

A sunny day in May saw the second Sopwith F.1 Camel Admiralty prototype, N.518, glide down and land at Martlesham. Tizard and his technicians examined it keenly, for it had a powerful new type of rotary, the A.R.1, sponsored by the Admiralty and designed by one of the naval engineer liaison officers, a 29-year-old named Wilfred Owen Bentley.

In 1912 Bentley and his elder brother Horace Millner Bentley had acquired the British agency for the French D.F.P. car made by Doriet, Flandrinet et Parent. Before long, young Bentley modified one of the standard family tourers into a competition racer, fitting aluminium pistons which then were novel and permitted greater engine rpm and horse-power. On joining the RNAS in 1914 he was commissioned Lieutenant, and when Eng Cdr W. Briggs, RN, O.C. of the Admiralty Aero-Engine Section, discovered Bentley's interest in tuning engines and his initiation of aluminium pistons, he took him on his staff at 'Victory House'. Bentley told me how Briggs and he found a 1913 Daimler-Mercedes in a London showroom, then drove it to the Rolls-Royce factory at Derby where they convinced Ernest Hives, who was in charge of the experimental shop, that it had the type of cylinder construction required for aero-engines, but that aluminium pistons should be used instead of cast-iron. Henry Royce's technical assistants, A. G. Elliott and Maurice Olley, accepted these proposals and initiated preliminary design of a prototype twelve-cylinder Rolls engine of 175 hp.

Bentley's next task was technical liaison between the Admiralty and Gwynnes Ltd of Hammersmith, well-known manufacturers of pump gear, who were the British licensees of the Clerget et Blin company of France, and were producing the 110 hp Clerget rotary. Bentley made a set of aluminium pistons to give higher compression ratio to a standard Clerget, and on test Gwynnes established that power had increased to 130 hp, and the engine was put in production as the 9B.

Cylinders of all rotary engines gave constant trouble, the big difference in cooling between front and rear faces causing distortion, with consequent loss of power owing to ineffective sealing by the circular piston and its rings. This necessitated the addition of a soft 'obturator' ring made of a sandwich of copper and silver which was plastic enough to mould to the

shape of the distorted cylinder and ensure no leaks, but it was a poor palliative. Rethinking the problem, Bentley proposed that cast-iron cylinders should be replaced by similarly air-cooled aluminium cylinders which had a steel lining, and he induced Gwynnes to make an experimental composite cylinder to his design. Tests proved it most satisfactory, and he then endeavoured to get Gwynnes to build a complete engine with such cylinders, but the directors were fearful that it would intrude on the commercial success of the standard Clerget which they now had in full production, and they dared not jeopardize royalty arrangements with the French company.

Camel N.518 was important because it was fitted with Bentley's A.R.1 engine, but it encountered early disaster at Martlesham, knocking off its undercarriage in a bouncy landing. The under cowling was slotted to give additional cooling. (*A. R. Boeree.*)

With Briggs's support he therefore offered the design to Humber Ltd who took the bold step of supporting this new conception of the 'Admiralty Rotary No. 1'. Their automobile engine technicians accepted responsibility for complete detail design based on the Clerget, and incorporated its successful overhead valve gear. To finance the project, Briggs secured allocations of £10,000 a time as work proceeded. Bench tests proved the engine an immediate success with a magnificent 150 hp. The prototype

Freddie Raynham, like his friend Harry Hawker, flew many types during the war. Here he emerges from the cockpit of the Bristol monoplane after making its first flight at Filton in June 1916. The original cabane shape was to give protection in a turnover. (*A. Coles.*)

was immediately installed in N.518 for flight testing. There was not even time to modify the Sopwith centre-section with cut-out and panel for better view. A second engine was earmarked for the latest Bristol M.1B monoplane, the Clerget M.1A prototype having been flown by Raynham in July 1916. So convinced was Briggs of the success of the engine that he had already given a production order to Humbers. Despite an initial nose-over, Martlesham tests of the Camel confirmed the suitability of Briggs's choice, and within a month Humber-built engines, now renamed B.R.1, were being installed in Camels, and by 4 July, 1917, No. 4 Naval Squadron was in action with them, attacking 16 Gothas some way off the Belgian coast.

During July a series of tests were made with a B.R.1, fitted to Camel B.3835, and systematic variation was made of compression ratio and induction system, which showed that the original engine had suffered from acceleration difficulty due to induction inertia, described as 'that old bogy of normally aspirated engines'. The aluminium induction pipes required much fiddling to allow for expansion at cylinder and crankcase joints. Compression was somewhat governed by the exhaust valve springs which were only strong enough to close at low rpm, but at higher revolutions centrifugal force automatically shut the valves. With compression ratio of 5·7:1 and large induction pipes which had 2 mm holes drilled in the top casting, 11 hp was gained, and in August the Camel showed remarkably increased climb, attaining 6,500 ft in 4 min 35 sec, compared with 6 min of the 130 hp Clerget prototype, and speed at 6,500 ft had increased some

10 mph. It sealed approval to Bentley's design, for the Clerget 9Df was not robust enough at its increased power and soon rattled itself to pieces.

Said Bentley: 'The Admiralty was exceptionally trusting over our experiments. Their outlook throughout the war was always in advance of the War Office in envisaging engine and aircraft developments for future requirements. Almost simultaneously with design of the B.R.1, Commander Briggs authorised me to proceed with the design of a still more powerful engine, the B.R.2. Without delay a prototype was built by Gwynnes. Within a week it had successfully completed a 50-hour acceptance non-stop run. Orders were immediately given to Gwynnes, Daimler, Crossley, and Ruston, Proctor. By the end of the war 30,000 were on order.'

Commander John Porte (left) revealed pioneering ingenuity in 1908 by building a two-seat glider introducing heavily staggered wings. In 1911 he became associated with the British Deperdussin Company, and in October 1913 turned to flying boats after flying a Curtiss at Brighton. W. O. Bentley (right) was a RNAS technical liaison officer who brilliantly applied his knowledge of car engines to improving the rotary aircraft engine.

The B.R.2 was not much bigger than the B.R.1, with a diameter of 1,082 mm compared with 1,064 mm, though its stroke was 180 mm compared with 170 mm for the B.R.1 and 172 mm for the still smaller diameter Clerget 9B.

When asked if his aluminium cylinders were influenced by Frank Halford's design of the BHP, where cast-iron cylinder heads were used on sheet-metal water-jacketed aluminium monobloc cuffs into which the cylinder steel liners were screwed, Bentley pointed out that this engine was really based on the Hispano-Suiza, and Halford's work was quite separate as he was attached to the Air Board and not the Admiralty. Certainly Bentley knew of the BHP because Briggs had been asked by the Director-General of Military Aeronautics to act as adviser on a dispute which had arisen between the military Engine Development and Engine Inspection departments because young Halford, classed as an inspector, had apparently broken the rules by designing an engine which the Development side considered was their province.

Lists published by the Germans of British aircraft which had fallen into their hands afford interesting indication of the numerical deployment of British aircraft in the spring and early summer of 1917:

Type	*April*	*May*
B.E.	35	6
F.E.	27	15 (including 1 F.E.8)
Nieuport single-seater	19	10
Sopwith 1½-Strutter	16	8
Bristol Fighter	13	—
Vickers Gunbus	11	5 (2 described as single-seaters)
Sopwith triplane	1	8 (1 described as two-seater)
Spad	4	4 (1 described as two-seater)

The May returns also introduced the Sopwith Pup, of which 21 were in German hands, and two S.E.5s as well as a lone D.H.2.

But in April the British Government was much more concerned that weekly losses of ships over 1,600 tons were steadily mounting. In the third week of April, 40 were sunk. The threat to starve England was becoming reality. There were exhortations to be frugal from the Food Controller, and a scale of personal rationing was recommended, emphasized by an Order restricting bread and meat for hotels and restaurants, with one meatless day a week and the famine-scarce potatoes limited to two days – though not applicable if the total charge for the meal including drink did not exceed 1s 3d; but teas costing more than 6d were illegal, and only two ounces of cake, bread or biscuits could be served. Even more far reaching was the Corn Production Bill which enabled authorities to supervise cultivation and prosecute occupiers of neglected land; but farm labourers at last were established with a minimum wage and statutory weekly half-holiday, and landowners who ploughed ground not immediately productive were granted a bounty. In a yet more breathtaking step the Government solved in a stroke the great pre-war problem of the militant suffrage days, for with the introduction of the People's Bill the entire franchise was simplified – and women of over 30 at last were permitted to vote.

In Parliament, Pemberton Billing was returning to the attack. 'I wish to express my regret for again having to detain the House on the question of our Air Services,' he said. 'I should like to congratulate the Under-Secretary of State for War on the frank statement he made in the House this afternoon. What is the first thing we find? It is that in the last six weeks 7·6 of our pilots have been killed each week, 8·3 have been wounded, and 4·2 are missing. I ask the Hon gentleman to say whether the average was taken on the whole Air Service including the thousands of aviators and machines in this country, or whether solely on machines and men in France. Assuming that the Director-General of Military Aeronautics made the very best case he could, it means we have lost in six weeks 20 per cent of our men, and if it continues this way then in six months the whole Air Service will be wiped out.' Pemberton Billing was deliberately

Noel Pemberton Billing (left) founder of Supermarine. On the table is a model of his proposed P.B.27 flying-boat with midship engine in the hull. Brig-Gen W. Sefton Brancker (right), was one of the great characters of British aviation. He learnt to fly in 1913 and was killed in the R101 in 1930. (*Photos Associated Newspapers Ltd. and Flight.*)

overlooking the input, but the rigorously censored figures certainly indicated that only 600 pilots were operational on the Western Front, and Mr Macpherson had said that 20 men a week were being lost. Accidents at home during flying training were causing even greater losses.

Turning to his main theme that B.E.s were still being used for gun spotting, and though obsolete were being ordered in large quantities, Pemberton Billing added with bitter edge: 'I have frequently said that the administration of Sir David Henderson is a menace to our Air Service and to this country. I could give the Hon gentleman lists of the men who surround the Air Service, which is being conducted on party lines, and the intrigue, because it is suppressed, is none the less real. In the Hotel Cecil it is now worse than ever since the outbreak of war.' Throughout the spring Pemberton Billing's attacks continued. 'There have been more men killed by pencils, by calculations that have taken place in our drawing offices, than by gunfire from the enemy in the air. The most elaborate calculations are constantly going on, and we have technical advisers who through their technical advice have cost this country millions of money and endless casualties.'

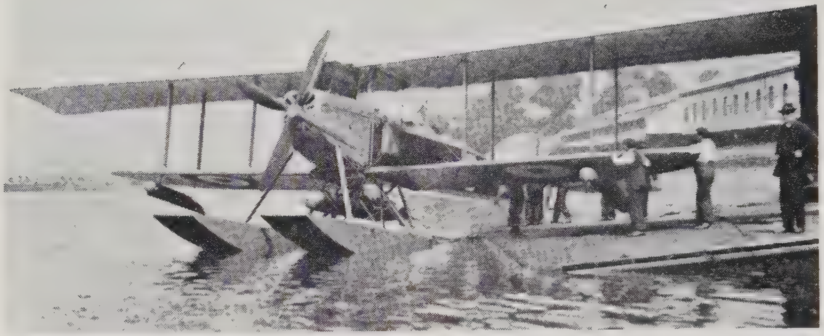
In concern of mounting air losses he was supported by Winston Churchill, who asked the Under-Secretary of State for War whether his attention had been drawn to the latest casualty list containing the names of 63 officers killed or missing, of which no fewer than 31 were aviators of the RFC, and he asked whether there had been an increase in air casualties during the last month. Perhaps neither he nor P.B. noticed in that casualty list the name of 2nd Lieut S. F. Cody, youngest son of that much loved pioneer, the late Samuel Franklin Cody.

A few days later that great man, Horace Short, eldest of the three Short brothers, died of brain haemorrhage. As one of the chief geniuses of the world concerned with the science of flying, he had both the faculty of attracting personal affection and at the same time inspiring almost awe at his mental ability and force of character. In a crowd he was immediately evident by his grotesquely large head, though as a child he was normal and handsome but may well have been affected in adolescence by a form of hydrocephalus which could account for his mental genius. To the young members of his company he was affectionately known as 'old Spike-bozzle', though they dared not address him as anything but 'Mr Horace'.

One who knew him well from earliest days, said: 'He possessed the most wonderful versatility of mind, for he was far above the mental level of the ordinary adventurous engineer. It was almost impossible to produce a subject about which Horace Short did not know as much as the leading authority on the subject. Hard facts of bridge building as applied to aeroplane girder design, theories of aerodynamic science, chemistry of internal combustion engines, naval and military and commercial possibilities of aircraft, were all within the ordinary scope of his daily work, but he was equally at home with advanced metaphysics, the legends of lost Atlantis, manners and customs and origin of South Sea Islanders, the mural sculpture of the Aztecs, Egyptian hieroglyphics, and the operation of comets. In early years he led a life of adventure in remote parts of the world, drawn thither always by engineering work, but pearl fishing in the Pacific came as easily as mining in Mexico, and those privileged to listen to his tales of wild happenings in wild places know that his life, brief as it was, contained enough material to stock many books of adventure.'

There were countless stories about him, from the sublime to the ridiculous, but all with a thread of truth – such as Ronald Kemp's recollection of a girl at Rochester 'who couldn't resist kicking him while he was bending down and caught him a fourpenny one – at which he stood up and roared, "Who did that – fetch her back – get her name – I *do* like a girl with a bit of spirit!"' And Lankester Parker, who succeeded Kemp and became perhaps the greatest of all flying-boat pilots, testing for Shorts through many years, told how: 'There came a time when Horace thought fit to dismiss a man and strong words flowed on the Medway tow-path. When really exasperated he had a habit of throwing his big hat on the ground to emphasise a point, which in this instance was the immediate dismissal of the man. The temptation was too great for the man, who took a running kick at the hat, and into the river it went. The unpredictable Horace thereupon beamed at the man with the remark that he liked a chap who showed independence, and sent him back to work.'

The 'kid brother', tall and powerful Oswald, now took over – for Eustace, the founder of the firm, was busily engaged at Bedford with construction of Admiralty rigid airships and valves for 'blimps', a word Horace had coined on seeing the Short-built S.S.3 semi-inflated, when he is alleged to have said: 'You call that an airship, Eustace! It's too b . . . limp!'



The prototype 310A, with the Shorts' Rochester works in the background and Oswald Short at right, was a replacement for Type 184 and carried a 1,000 lb torpedo and had a 320 hp Sunbeam Cossack engine. On trials the prototype broke up in the air due to a fault in the float undercarriage structure. (*Short Bros.*)

Remarkable for his tremendous strength – for he could hold a 56 lb weight at arm's length – Oswald was now 34, and although, like the whole company, long overshadowed by the still stronger personality of Horace, he had obtained tremendous experience from the great series of seaplanes his brother had evolved with such insistence on first-class workmanship that the phrase 'Short built' was regarded by Naval men as expressing the highest standard of safety and strength. Like Horace, Oswald had an obstinacy based on the power of his convictions. If either brother negatived a proposed construction not even the Admiralty would press the matter further. No man ever shifted them from a fact, nor could money tempt them. They went their own determined way, contemptuous of publicity, severe in censure in their own workshops, resolutely ensuring that the British seaplane industry held in relation to other nations the equivalent place long occupied by the British shipbuilding industry.

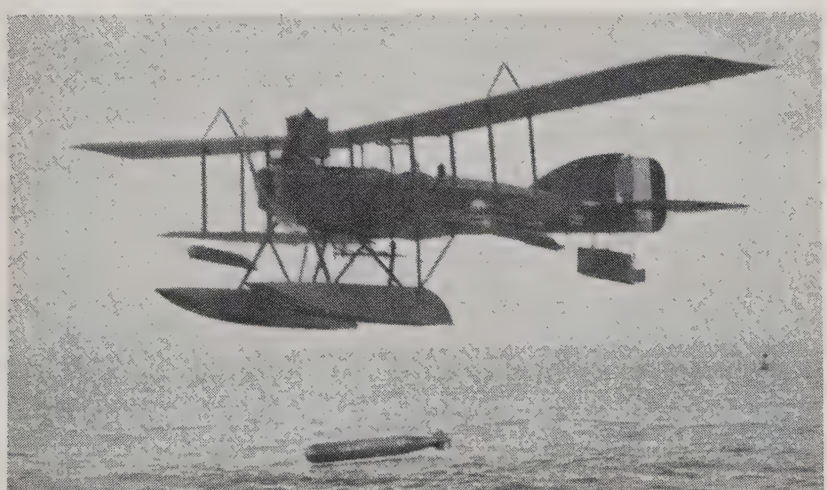
Lankester Parker wrote of Oswald that: 'A lesser known trait is his highly developed artistic sense, some of his water-colour paintings being of considerable merit. He is also very fond of classical music; Beethoven and Schubert are his favourite composers. For years after he achieved financial success he remained frugal in his living; his house was small though his furniture was mostly antique and of excellent taste. Withal he was most generous – although I think porters and waiters may sometimes have thought otherwise. He hated tipping heavily for a slight service when, as he said, so many of his employees deserved it so much more. He is an authority on insects and can discourse learnedly on astronomy. There are few subjects in which he is not interested. In the forty-four years I have known him I have never seen him bored. His approach to any subject was invariably original, though he could be very stubborn. He sought the real, the simple truth.'

In explaining the development of his great company, Oswald Short sent

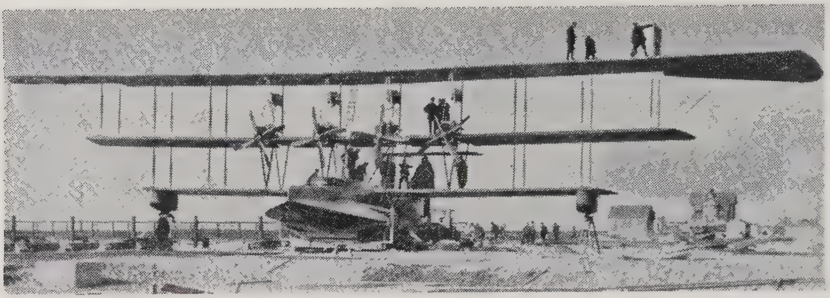
many letters to me, written in immaculate, rounded hand even when he was 80 and over. In one he wrote: 'In 1916 we made ourselves a private limited company on the advice of Sir John Thornycroft who visited our works at Rochester, but had no financial interest in our business. Our registered capital was £150,000. That was the value of the works at Rochester and Eastchurch representing the position that had been achieved in about eight years. It was done by ploughing all profits back into the business.

'When war broke out it was realized by the Board of Admiralty that the demand for Short seaplanes would be greater than the firm could deal with, and at the request of the Government we granted licences to 13 other firms to manufacture our products. Their staffs underwent tuition at our Rochester works, and all the companies were given substantial orders. For each type about 1,000 blueprints were supplied at cost to each company. In this way we launched several aircraft companies in business – such as Westland, Fairey, Supermarine, English Electric, Parnall – and they were to remain in competition with us in the years to come. We asked in compensation for this work a cash payment of only £20,000 – which was spent almost immediately in excavating the riverside chalk at Rochester in order to erect No. 3 shed, the exact cost of which was £18,000 and was not recoverable.

'Unfortunately in drawing up the Royalty agreements we did not seek legal advice and stated we should receive 3 per cent on complete machines and on spares supplied therewith: we meant on all spares such as floats, wings, fuselages, etc., but when it came to settlement the Treasury solicitors maintained that the word "therewith" implied only those spares ordered simultaneously with complete machines, and any ordered separately were



Subsequent Short 310s had a modified float heel bracing with additional struts outboard to the wing which had to be removed for folding. The gunner stood in a pulpit to operate a Lewis gun on the centre-section. (*H. Busteed.*)



Little known is the Curtiss Model T four-engined 1,000 hp triplane shown being erected at Felixstowe, in 1917. Significantly the control surfaces were power-assisted by windmill driven drums. (*Courtesy Peter M. Bowers.*)

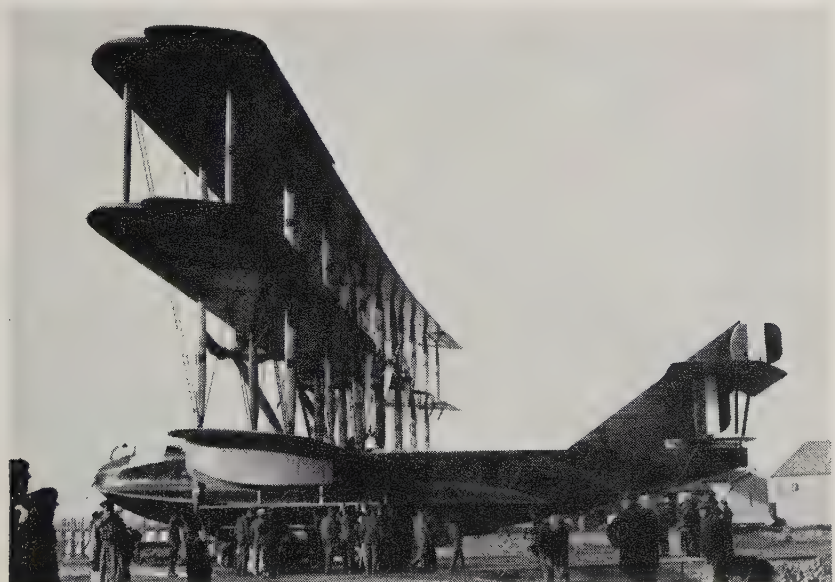
not subject to payments. Had we but written the word "therefor" instead of "therewith" all would have been well, but the Treasury stuck to its point and we lost about £170,000 in royalties.

'What with this and the Excess Profits Tax, I started the new era of my personal control with considerable sense of grievance, but very much aware that the existence of Short Brothers now depended on my ability to design new types of aircraft. At about this time certain young officer pilots who had a degree of technical training were appointed to the Board of Admiralty to consider and approve designs. They now had their own ideas about aircraft design, and though a wise designer listens carefully to a pilot's criticisms of his machine, learning thereby and sorting truth from prejudice, I could not stand being told that our success in the past was due to having no competition when in fact we had initiated work for so many firms. What I thought of them I explained on the spot, but it was very evident that these two young men desired to achieve fame and promotion by designing aircraft themselves, and to that end they sought to establish a designing department in the Board of Admiralty, and later in the Air Ministry, where they remained a thorn in the flesh.

The 1,670 hp Felixstowe Fury beginning its take-off run in smooth water opposite the Marine Aircraft Establishment at Felixstowe. The hull produced a cascade which impinged on the lower wing; nevertheless seaworthiness was superior to the F-boats. (*Courtesy The Royal Aeronautical Society.*)

'Another difficulty was the precedent established at Felixstowe Air Station where Commander Porte had apparently secured a licence to build Curtiss flying-boats which he developed as the F.2A, and had them built in large numbers. Though the F.2A had good performance it was almost unmanageable in turbulent air, and was presently replaced by the F.3 and F.5 of which we were the leading constructors. However, Porte was so biased towards flying-boats that he stated he would not have a Short seaplane on his Station which was the main base for official trials, but though he had not got the power to bring about such a state of affairs it certainly meant we could not expect the good points of Short seaplanes to be stressed. Nevertheless our seaplanes persisted, and far more were built than flying-boats during the war. A new type of flying-boat was ultimately designed and constructed at Felixstowe – a triplane – which became known as Porte's Super Baby, and eventually crashed, it was said due to having such good water planing properties that it left the water before it was airborne! After that unhappy episode no further flying-boats were built there.'

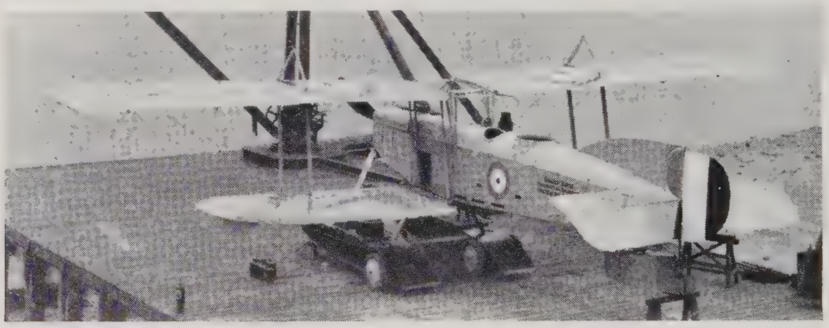
The triplane was officially named the Felixstowe Fury, and was developed from a huge American-imported triplane, the four-engined Curtiss Model T, probably by rebuilding in the light of F-boat experience, for the Fury's empty weight became 3,000 lb heavier for an identical all-up flying weight. The Fury may well have inspired the Shorts to devise a twin-hulled



Bearing strong resemblance to the Curtiss T, but with the middle wing having equal overhang with the top, the Felixstowe Fury, dubbed the Porte Super Baby, had an altered bow compared with the Curtiss. It was originally designed for three 600 hp Rolls-Royce Condor engines, but owing to their unavailability five Eagles had to be substituted. (*Courtesy The Royal Aeronautical Society*.)

flying-boat of similar size, with two tractors and one pusher engine, for which Patent No. 131,045 was subsequently granted.

As Oswald Short put it, he himself 'became a decision maker, closely supervising the design of aircraft'. In fact he had been in charge of design some months, and recently had drastically revised a small single-bay seaplane Scout which had been his brother's last design. Horace had built two prototypes, but when Ronald Kemp came to test the first, N.36, in January he could not get it off the water. 'Well, of course early in 1917 old Spike-bozzle was beginning to lose his grip,' he told Chris Barnes, author of *Shorts Aircraft since 1900*. 'Murray Sueter had been posted to the Med,



The Short Scout N.2A flown in January 1917 may have given a lead to Fairey's later design of the F.127 of similar geometry and size. Known as Scout No. 1, the fuselage of this Short was lengthened by 2 ft and was then referred to as Scout No. 2.

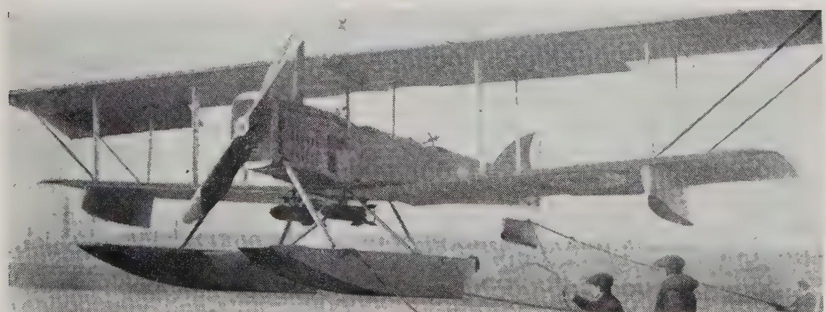
and he felt rather at the mercy of the new men at the Ministry of Munitions, including Ogilvie.' From this unsuccessful machine Oswald derived S.364, detailed by Francis Webber and Percy Jones, and it had been flown by Lankester Parker on 27 March. Barnes comments: 'Bearing in mind that Horace died on 6 April, S.364 might well have been put in hand in January with Horace's blessing but without his intervention in later stages of design. It went on to Grain, and apparently had a 260 hp Maori substituted for the original Sunbeam Afridi, and larger main floats were also fitted. This is consistent with Parker's first flight test report that S.364 was "tail-heavy and seriously underpowered", and substantiates a later Grain report that its military load had to be limited to two 65-lb bombs additional to crew of two, Scarff ring and Lewis gun.'

In his Short Bros commemorative lecture, John Lankester Parker in referring to this period, said: 'Soon after this Ronald Kemp, one of the very great pilots of the earliest days, left the company and I succeeded as chief pilot. Oswald designed a replacement for the standard 184 seaplane, called the N.2B, powered by a 260 hp Sunbeam. It was a beautiful aeroplane, but was not put into production. It is only fair to say that his intention was to fit N.2B with a Rolls-Royce Eagle of 375 hp, but an Air Ministry official, who ought to have known better, somewhat insultingly told him that any aeroplane could be dragged through the air given enough

As alternative to Horace Short's Scouts, Oswald Short designed independently a two-bay seaplane to the same specification, known as Scout No. 3 S.364, which except for the balanced rudder revealed a complete breakaway from traditional Short conception. (*Short Bros.*)

power. Subsequently Oswald borrowed one from stock intended for their production F.3 flying-boats. The effect was extraordinary. It had the quickest take-off of any seaplane I have known, something under five seconds, and it climbed easily to 16,000 ft with full load. For fun I used to take-off across the Medway where the width was less than 200 yards.'

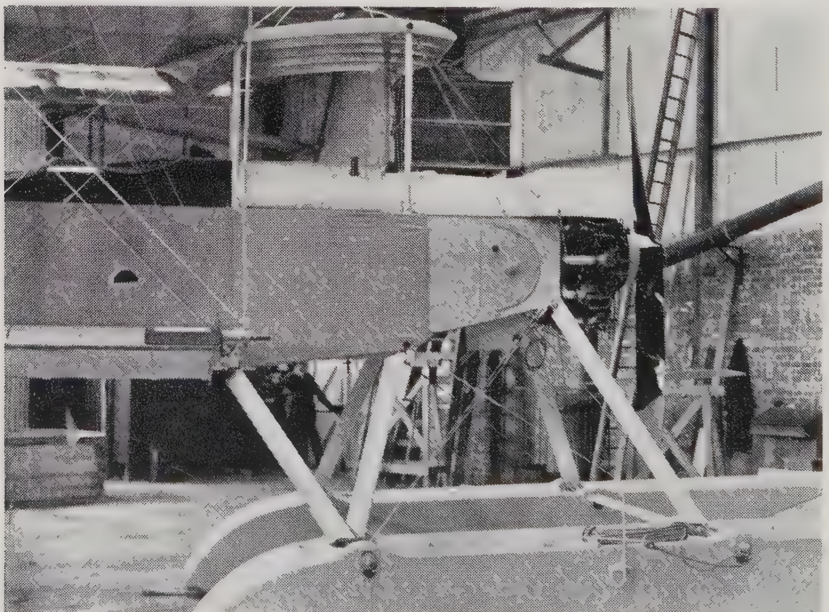
Nobody in the world had greater experience of seaplane behaviour than Oswald. Floats had been his speciality from the beginning. Simple exercises in boat-building though they might appear, these pontoons complied with onerous factors: designed for minimum air and sea resistance, they must be so capable that the floatplane could put to sea in everything except lifeboat weather. It might run out of harbour in the face of a strong breeze and heavy sea, or be launched from a mother-ship either by hoisting over the side by derrick, or projected from the deck by launching catapult, or even carried to sea on the back of a submarine which acted as a floating dock by submerging far off-shore to launch the seaplane. Often on getting under weigh the floats might be completely submerged in solid water, but must withstand tremendous butting into waves as speed increased. On



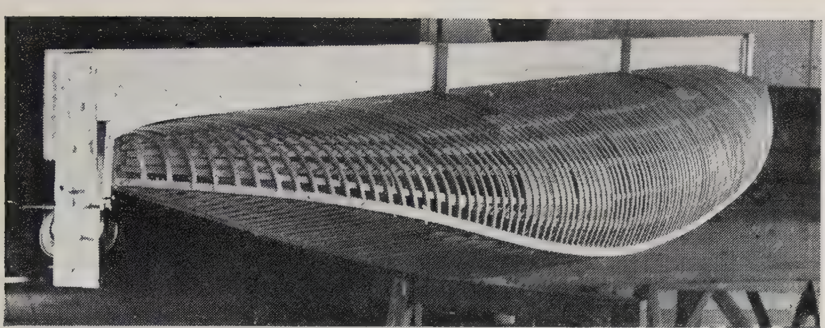
The Short N.2B was a long-range two-seat patrol seaplane intended as a replacement for Type 184, and it was again hallmarked with the new design outlook of Oswald Short. Competing with it was the two-bay Fairey III. (*Short Bros.*)

reaching planing speed at about 20 mph, a seaplane would often be thrown clear of the water by even a light chop, or projected below minimum flying speed from the steep incline of a bigger wave – when it would flop down again, often flat on the bottom of the float or digging in the heel. Such hopping, with heavy impact on the water, might be repeated over and over again until sufficient speed was gained to jump from a wave crest and enter steady flight perhaps only a mile or two above stalling speed.

From personal experience of setting a seaplane down on the long swell of the open Atlantic, when the metal floats' bottoms concaved between formers, I can appreciate the problems Oswald had in making his brother's great seaplanes safe for their onerous operations of submarine spotting in every kind of weather. No less complex were the requirements of static and dynamic stability, for floats must give adequate restoring couples under the pitching and rolling action of waves, which are heavy in a seaway and complicated by heaving due to vertical motion of the water. This entails sufficient longitudinal stability to prevent the machine falling back on its tail or forward on nose, nor must it roll so far that the wing-tips will be damaged; yet many a designer has provided floats which were too short, so that the machine has fallen on its tail and finally turned over on its back; other floats have been so fine at the bows that there was insufficient bearing surface to prevent tipping nose first when alighting or getting under



Flat-bottomed box-like pontoons characterized early seaplanes because they were simple carpentering jobs. Shorts added the refinement of sprung cross-beams. The Short patented leading-edge dowel lock of the folded lower wing can be seen.



By comparison with pontoon floats the Linton Hope float was a boat-building masterpiece of ½ in multi-timbers, double diagonally strip-planked, enabling flowing sections for minimum air drag and maximum water efficiency. (*S. T. A. Richards.*)

weigh. Even the precaution of keeping thrust lines as low as possible introduced risk of propeller tip damage through cascades of water as the seaplane accelerated. Despite racking and straining imposed on the supporting strut structure, twin-float landing gear was very satisfactory for all-round service provided the main floats were not too far apart, otherwise one float submerged more than the other and the seaplane spun round quickly due to increased resistance of the immersed float and its leverage from the centre-line. Even the hydrodynamic characteristics were less sensitive than those of a flying-boat hull, but the National Physical Laboratory was particularly studying this aspect in the William Froude water tank.

7

It was at the Shorts' old home flying ground of Eastchurch and at the rough new aerodrome on the shores of the Isle of Grain that a tremendous amount of Naval flying trials and development work was being carried out. The latter was one of those established for the Navy by Winston Churchill in 1913 because of his conviction that war with Germany was imminent. He arranged for a line of coastguard cottages to be taken over at Grain and had them converted for the officers and men as a matter of utmost priority. A number of tufty grazing fields were made into a small aerodrome, and Bessonneau hangars were erected within the sea wall, a slipway made, and workshops built where a disabled engineer officer, Sqn-Cdr G. W. S. 'Gerry' Aldwell, was placed in charge of a unit known as the RN Aeroplane Repair Depot of Port Victoria. Alongside it a separate section was established towards the end of 1915, known as the Experimental Armament Section under command of Lieut-Cdr Robertson, RN. It was but a further step for Harris Booth and Sqn-Cdr John Seddon, RN, of K Section Admiralty Air Department to propose to Commodore Murray Sueter that an Experimental Construction Section be added, and the Navy would then have the nucleus of a miniature Farnborough. Renamed the Marine Experimental Aircraft Depot embracing the Experimental Construction Department, Seaplane Test and Development Section, and

Experimental Armament Section, its Construction Section was located in the big galvanized-iron Salvation Army building which had been transported to Grain to house the original Repair Depot, and commenced constructional work early in 1916 with a former model aeroplane manufacturer, Capt W. H. Sayers, RFC, as Technical Officer.

At the end of that year, Aldwell was transferred to command Dunkirk Repair Depot, and Grain Depot became administratively under Grain Air Station with Sqn-Cdr H. M. Cave-Browne-Cave as Officer Commanding. By this time it comprised three large sheds, of which the first was a machine and fitting shop, the second an erecting shop, and the third a running shed. The Test Flight had become a separate department with sheds at the main Air Station, which was now established as an Acceptance Depot under Major C. E. Risk, RMLI.

Launching a Parnall-built Baby, which differed from the Fairey by retention of Sopwith main floats, fin, and rudder. An ultimate variant was the Convert with skids and wheels replacing the floats giving unconventionally wide track. (*H. Busteed.*)

Work at the Experimental Construction Department, known as ECD, was initiated by the forceful and inventive Commander Seddon – who had commenced his somewhat stormy aeronautical career in 1912 by flying into a hangar door, and thus led him to build his next machine from bouncy hoops of steel tube. He was concerned because the Sopwith Baby seaplane was being flown operationally at loads which made take-off precarious, for it had to carry a 60-lb bomb on anti-submarine patrols. In anything like a sea the floats broke under wave impact before the machine could rise. The new 110 hp Clerget with an open-fronted cowling was substituted for the bull-nosed Monosoupape, and the floats were given improved hydrodynamic shape. For this form of the Baby the Blackburn and Fairey companies were given contracts, but the power increase was used by the Navy to uplift the load by carrying two 65-lb bombs instead of one, together with Lewis gun, ammunition, sea anchor, emergency rations, and in the absence of light-weight radio one or two pigeons were carried. Inevitably it led to another step up in power using the 130 hp Clerget. By

this time, strength factors were inadequate, and the two companies had to stiffen the wings.

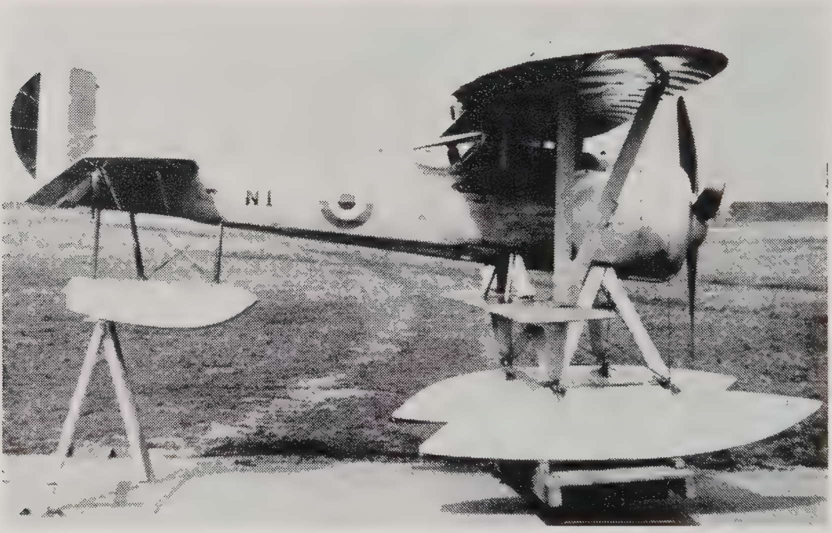
Seddon proposed that an aerofoil of greater camber should be used, and it was this which had prompted Fairey to consider deflecting the entire trailing margins, yet use them independently as ailerons. It was not the first attempt at variable camber, for the Varioplane Co Ltd had been working some years on a system patented by A. W. Judge and A. A. Holle for a somewhat complex lever method of flexing a wing surface, but Fairey's approach was that of the practical engineer, using one abrupt change of camber and then applying an ingenious geometry of cable operation to give either simultaneous or differential application of the flap. Fitted with wings of 2 ft greater span, greater chord and increased depth, using the original fuselage of Baby No. 8134, though with fin and rudder replaced by those of his own design after fitting pontoon floats, the machine was test-flown at Hamble by his friend Sqn-Cdr Maurice Wright, RN, and in its new guise lifted two 65-lb bombs with much greater alacrity, though control feel was not so pleasant owing to the great weight of moving the large flaps as ailerons. Named thereafter the Hamble Baby, production orders were given to Fairey and to Parnall, though the latter constructed the greater number, supplying 65 seaplanes and 75 landplanes.

At Port Victoria Seddon took a much cruder line in replacing the thin section wings of the standard Sopwith Baby with heavily cambered aerofoils based on NPL wind-tunnel work, giving the wings the same area, but greater span with smaller chord and pronounced stagger for better climbing efficiency. Taking a standard Baby he sawed off the stub lower wing spars flush with the fuselage sides, and clamped on the new mainplanes at a position giving the pilot the best view, adjusting the C.G. with 300 lb of lead in the lengthened floats. The little P.V.1, as it was called, vindicated itself by taking-off at an all-up weight of 2,180 lb compared with 1,715 lb for the standard Sopwith Baby and was free of sogginess, but speed was only 67 kt.

Spurred by success ECD turned to a fighter seaplane for anti-Zeppelin duties, armed with a single 2-pounder Davis gun on the upper wing. In the general arrangement of this V-strutted Monosoupape-engined light fighter, which weighed no more than the Baby, Harris Booth and Harold Bolas seem to have had no hand, though they were the usual inspirers of the Air Department's designs. Commander Seddon had proposed a shoulder-wing monoplane to Sayers, using a similar high-lift wing to P.V.1, braced direct to the float undercarriage, but to make the machine more compact for its area, a sesquiplane lower wing was cleverly incorporated clear of the fuselage, for which a Sopwith Pup structure seems to have been used, faired to circular section with hoops and stringers. By its entire elimination of bracing wires the P.V.2 chronologically beat Curtiss and Fokker designs, but when flown in June 1916 it not only suffered defective lateral control through flexing of the long ailerons but was slower than the latest Baby and the Pup landplane.

The ailerons were halved and stiffened and then found satisfactory, but

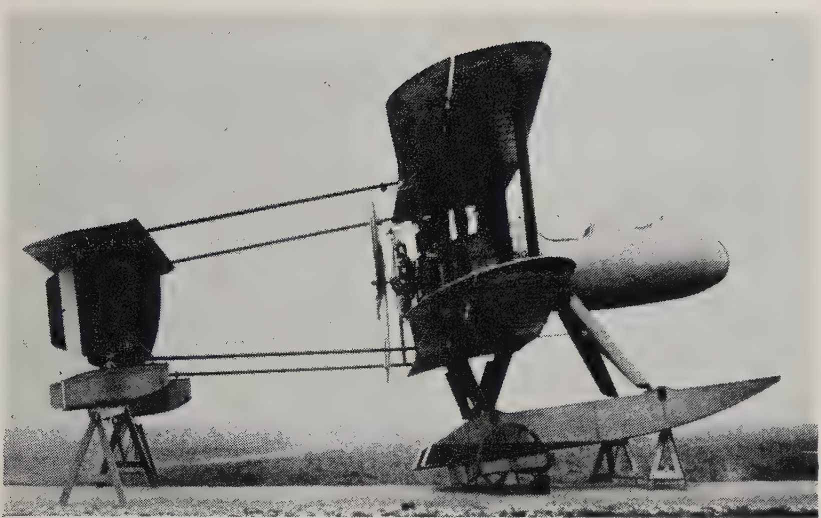
by the time the machine was ready the Davis gun had been abandoned due to defects, so two Lewis were fitted. Pilots complained of blanketing of view by the upper wing, so it was raised 1 ft to eye-level and a centre-section inserted to move the wings outboard and keep interplane struts in their original outward-sloping line. Tested early in 1917 the P.V.2bis version was greatly liked, but by then it did not seem expedient to disturb the successful production of Fairey's Hamble Baby.



The Grain-built P.V.2bis was a modification of the prototype to give better landing view by raising the upper wing and inserting a centre-section. The floats were a compromise between Linton Hope and flat-bottomed pontoon construction. The machine was popular but outdated when eventually tested in March 1917. (*Imperial War Museum.*)

Two machines of widely different geometry and character next became the responsibility of Port Victoria's design technicians. The first was P.V.4, a complete rethink of the 1916 A.D. Navyplane two-seater, and intended for the same American-designed 150 hp Smith Static ten-cylinder radial which weighed only $2\frac{1}{2}$ lb/hp. Like the first version of P.V.2, it was a shoulder-wing sesquiplane, but as a pusher had tail-booms conventionally converging on a single vertical rudder-post – whereas the Navyplane, which Seddon says was designed by Bolas assisted by a young man at Supermarines called R. J. Mitchell, had the tail-booms separated and terminating in twin fins and rudders beneath the tailplane. Both pushers suffered delay because of non-materialization of the American engine. Fitted with an A.R.1 the Navyplane was tested late in May, but it was clear there would have to be a long period of development.

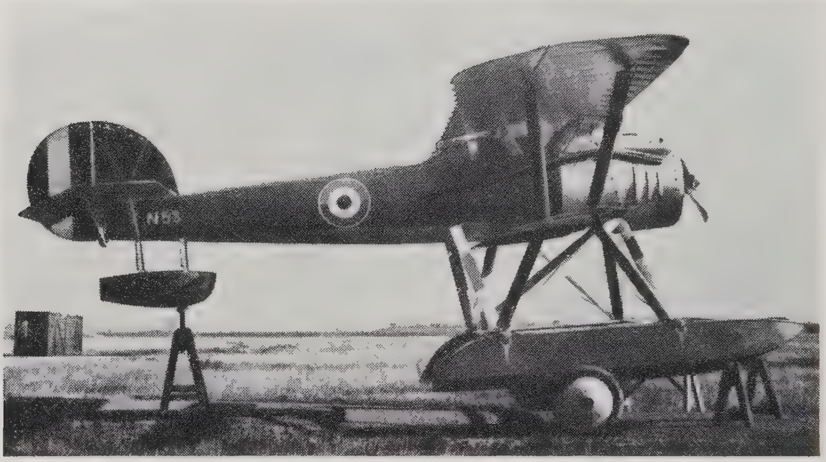
Hope was pinned on P.V.4 with a 110 hp Clerget instead of the Smith – but this led to complication owing to greater overall length of the engine, for it placed the carburettor in the middle of what should have been the



The Admiralty's interest in developing the troublesome 150 hp Smith Static engine spelled too long a delay for a number of aircraft. Thus the A.D. Navyplane after early flights was powered with the more reliable 150 hp A.R.1 rotary when flown in May 1917. (*Imperial War Museum.*)

fuel tanks and the propeller hub was a foot farther aft than intended, the C.G. moving proportionately. The result was disastrous. Full-out the machine was very tail-heavy, and with engine off lost all longitudinal control below 55 knots. 'This characteristic led to her alightings being quite picturesque, and incidentally afforded an excellent strength test of experimental Linton Hope type floats with which she was fitted,' commented Seddon.

Also originally designed for the Smith Static was Port Victoria's P.V.4 but delayed by absence of engine until summer of 1917 when a 110 hp Clerget was installed. The semi-circular rudder was typical of design by Capt Sayers.



The Port Victoria P.V.5 sesquiplane fighter was also intended for the Smith Static. Only after six months' delay was a 150 hp Hispano-Suiza made available instead. The wings were braced by struts to the undercarriage, similarly to P.V.2, but a 5a version was also built with conventional equal-chord wire-braced RAF 15 wings. (*Imperial War Museum.*)

Meanwhile the alternative tractor P.V.5 was being designed as a single-bay twin-float seaplane in the form of an enlarged P.V.2 similarly dispensing with flying wires and using high-lift wings. For comparison a 5a equivalent was put in hand with wire-braced equal-chord wings of conventional thin section and greater gap.

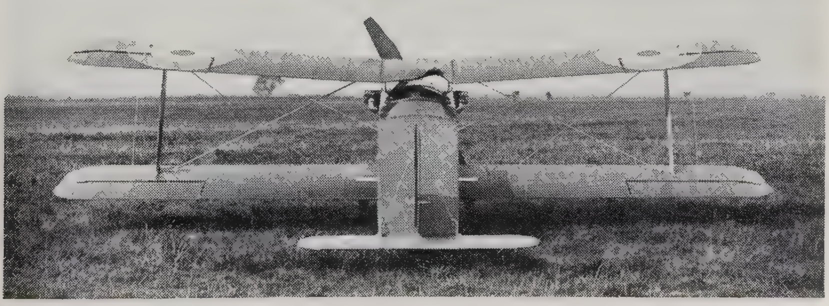
While they were under construction John Seddon made the startling proposal that miniature aeroplanes capable of carrying a Lewis on the centre-section should be adequate to attack Zeppelins, the low cost enabling them to be built in the hordes pictured by Pemberton Billing and others as a sop to the public against their fear of aerial invasion. Jack Seddon made the comment that he had never heard of the phrase 'Port Victoria Series' of designs as the soubriquet of machines built while he was

Forerunner of ultra-light biplanes was the conventionally structured but minute Grain Kitten P.V.7 of 18 ft span and only 85 sq ft area, powered with an inadequate 35 hp engine. (*H. Busteed.*)

Smaller even than the Grain Kitten was the diminutive 16 ft 3 in span 50 hp Sopwith Bee using Pup components but with wing warping instead of ailerons. It was soon relegated as a runabout for Hawker. (*Fleet Air Arm Museum.*)

there, and added: 'The original idea of the P.V.7 Kitten was in fact my own at a time when I wanted to demonstrate that manoeuvrability was as important as speed. I had no hand in the actual design after suggesting the project, and it was delegated to Sayers. Powered by an A.B.C. Gnat of only 35 hp it unfortunately never achieved the speed expected. It was outstandingly manoeuvrable, but that, of course, was not enough, and Aldwell told me that the Kitten was a disappointment.'

But at Eastchurch Sqn-Cdr Harry Busteed soon heard of this miniature biplane, which followed traditional Port Victoria lines using a big high-lift top wing. With his chief technical officer, Lieut G. H. Miller, RNVR, he devised a neater rival, the P.V.8, in the form of an **I**-strutted biplane using cut-down wings, interplane struts and fittings from a crashed Sopwith triplane, adopting the same stagger. They then built a small fuselage of the same form as the Bristol Fighter using adaptations of Sopwith spacers and fittings, making it the same depth as the triplane fuselage at the cockpit.



With 20 sq ft greater area and higher aspect-ratio wings than the Grain Kitten, the Eastchurch Kitten P.V.8 was a better performer and could carry a Lewis gun on the centre-section. The illustration shows the machine before a triangular tailplane was added. (*H. Busteed.*)

On 1 March, before it could be completed, Busteed was appointed to command the Experimental Flight Section at Grain, and the partly built Eastchurch Kitten was taken to Port Victoria for completion. Inevitably its Sopwith wings were cause of confusion, so it was generally referred to as the Sopwith Kitten. At this point the Sopwith company, at Harry Hawker's instigation, also decided to attempt a miniature Zepp-strafer which took the form of a still smaller biplane of only 16 ft 3 in span and 14 ft 3 in long, powered by Tom Sopwith's pre-war 50 hp Gnome from his Burgess-Wright biplane. Known as the Bee, Hawker ultimately used it as his runabout when visiting Sopwith contractors to test their machines.

The Grain miniature was completed before the others. Harry Busteed's log book records: '22 June. P.V.7 – N.539. Preliminary test of A.B.C. 35 hp machine. Very favourably impressed. Smallest flying machine in the world.' Not until 7 September was P.V.8 ready when he made one straight flight, commenting: 'Much too quick fore and aft.' Its floating Morane-type tail made it tricky longitudinally, but this was overcome by fitting a small triangular tailplane and removing the major portion of the elevator balance area except for small horns at the tip. Busteed's next report on 26 September stated: 'Excellent machine to handle,' after which it went to Martlesham for brief handling trials. It proved far better than the Grain Kitten, despite rebuilding the latter with wings of more conventional form, coupled with a new tail unit made in an endeavour to overcome extreme tail heaviness. Although intended for a 45 hp A.B.C., the P.V.8 with a mere 35 hp engine attained 95 mph at ground level, and climbed to 6,500 ft in 11 min, with a ceiling of nearly 15,000 ft.

Busteed's log reveals not only that he participated in much testing although he was Commanding Officer, but also the extent of experimental work undertaken at Grain. His entry for 25 July relates to the first flight of P.V.5 with 150 hp Hispano: 'Preliminary test. On landing one float carried away. Machine sank, but was salved later. Seemed good.' Four days later repairs had been completed and it was flown again. 'Machine gave a good impression,' he recorded. 'Tail adjustment kept working back. Decided to land. Bottom came out of float.' It was all in the day's work.

Many entries relate to experimental flight investigations of deck-landing systems, particularly arresting gear, which Seddon had initiated. 'We were given the task of trying to do this,' he said, 'by flying an aeroplane into half a dozen or so steel-wire ropes suspended in a half catenary over a heavy wooden frame, and spring clips were fitted under the axle to grip the wire ropes. I had two or three shots at this, though I did not much fancy the job, but it worked all right in a clumsy sort of way, but the system was quickly abandoned in favour of experiments at Eastchurch using a hook arrester.

'Another experiment was launching seaplanes into the air from the land in order to eliminate risks and delays inseparable from operations off the water. I did this by putting them on railway trucks and charging down our siding at Grain under the aircraft's own power. It was entirely successful, gave one a thrill, and was good fun. A much later experiment, arising from

A Sopwith Pup, at the Isle of Grain, fitted with arrester hook and metal skids to prevent nose-over about to touch down at the beginning of a wooden dummy deck which had raised transverse wires attached to sand-bag drags.

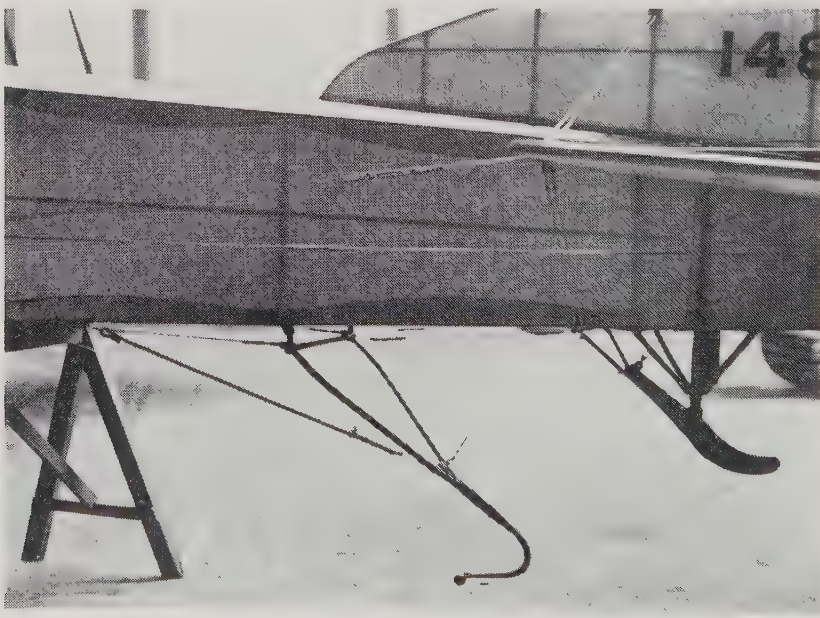
the public's alarm at Zeppelin raids, was the attempt to fly a B.E.2c under a blimp at 10,000 ft, so that it could be taken on patrols of long duration and released to fight when the quarry was sighted. Alas! It ended in disaster and the death of the two pilots – Commanders Usborne and Ireland. Both were well aware of the grave risk they faced, for in order to avoid a few weeks delay – such was the pressure of public opinion – it had seemed inexpedient to wait for safer equipment to be designed and made.'

Within a few days of appointment to Grain, Busteed made his first

At Grain the Admiralty Pup was known as Sopwith Type 9001. Early deck-landing modification was made by attaching a skid system to the standard sprung V-undercarriage and fitting a self-locking arrester hook.

Following the tragic accident to Sqn Cdr E. H. Dunning after his initially successful pioneer deck landings on HMS *Furious*, Sqn Cdr Busteed continued investigation with an identical Pup having the next serial number. (*Courtesy H. Busteed.*)

attempts at landing on a dummy deck, using a modified Beardmore-built Pup, N.9901, with hook dangling beneath, which picked up successive transverse wires attached to sandbags each end. Continuing experiments showed that arresting was a small part of the problem. Lack of deck width



A number of deck landing arresting systems were tried from early 1917 onwards. The illustration shows the experimental hook fitted to what is believed to be the catapult-launched Avro 504H. (*H. Busteed.*)

was more important than length, because the tendency was for the aircraft to swing sideways in turbulent air generated by the ship's motion, or oblique gusts caused the machine to slew, and tyres would roll off the wheels, resulting in the machine spinning round. The first attempts to land in this manner ended fatally when Sqn-Cdr E. H. Dunning, DFC, cartwheeled over the side with his Pup after two successful touch-downs. To reduce such risk a Sopwith Pup was fitted with skids attached to the axle instead of wheels, and later a rigid skid chassis was adopted, using longitudinal cables stretched fore and aft along the landing deck so that projecting snap catches on the skids allowed the stretched wires to enter on alighting and then positively hold down the machine to restrain sideways motion.

Early deck trials on HMS *Vindex* were made with a single-seat Sopwith 1½-Strutter using skid undercarriage developed by Sqn Cdr Harry Busteed at Grain for use with deck troughs to keep the machine straight during take-off. (*Courtesy H. Busteed.*)

Until satisfactory arrangements for deck landing could be evolved, and in the absence of seaplanes with performance approaching landplane scouts, the expedient was adopted of equipping ships with Sopwith or Beardmore Pups which could be flown off deck, but must either return to land or alight on the water near a friendly ship in hope that the pilot could be rescued. Air-bags were fitted in the rear fuselage to buoy the machine by the tail, but this was too uncomfortable a refuge in wintry seas and led Busteed to devise light flotation arrangements, which he patented, whereby land machines would float right side up in any reasonable sea. Deflated bags were folded flat under the lower wing, held by a fabric flap which could be released by pulling a string from the pilot's cockpit causing compressed air to be fed from a standard air-starting bottle, and the inflated

bags then gave large buoyancy ahead of the C.G. in conjunction with the fuselage bags behind the C.G.

The system was first tried on a Pup fitted with droppable undercarriage, but on glissading on to the sea the fabric under the fuselage ripped off, water rushed in, and the machine almost turned over. As remedy a stiff three-ply fuselage planing surface was fitted, and successful ditching tests led to similar arrangements for two-seaters, beginning with the 1½-Strutter, but eliminating the dropping chassis as pilots regarded it with distrust. Instead, as a result of his pre-war experience with the Bristol hydroped monoplane, Busteed decided to add a forward hydrofoil to the undercarriage, and the uninflated air-bags were rolled and clipped in a fabric bag each side of the fuselage from nose to under the wings. Again tests proved successful, and led to applications for many other aircraft, including a Voisin for the French which 'made a colossal splash on striking the water, but was successfully induced to float the right side up and undamaged'.

Making overwater flights safer for naval pilots led to an experimental Sopwith 1½-Strutter with inflatable air-bags to sustain it and paravanes to prevent it nosing over, and the system was for a time standardized on all naval landplanes. (*H.Busteed.*)

In all such test work there was a big element of risk, though compared with fighting in French skies it was discounted. Yet there were many reminders. On 12 May Rowland Ding, pre-war exponent of the Handley Page biplane and founder of the Waterplane School at Northern Aircraft Co Ltd, of Windermere, was fatally injured when the wings broke from a B.E.2c which he was looping while testing for Blackburns.

Revelations in the Paris Courts, during May, of the financial affairs of Armand Deperdussin, the famous French aircraft constructor, intrigued British manufacturers, for his company had enjoyed war-time orders to the tune of £2,800,000, and recently was taken over by Blériot to form the Société pour Avions et Dérivés, producers of the outstanding Spad fighter adopted by the British and French Air Services. Between 1903 and 1913 as a commercial traveller in a Silk Trust he handled a turnover no less than eight million sterling – a tremendous sum for that time, but now was accused of mis-diverting to himself some £640,000, of which £250,000 was spent on his aviation interests. Deperdussin was sentenced to five years and immediately released after the Judge had told him that 'The heroes of France had come to shelter him with their wings', and the Comptoir Industriel et Colonial who had backed his silk deals received 1 franc damages.

But from that same war-torn France, Philip Gibbs, writing from GHQ to the *Daily Telegraph*, turned to more desperate things: 'In the daily official reports a brief picture has been given of the battle which has raged in the skies while the soldiers have been struggling below. There have been hours when I have heard overhead a continued tattoo of Lewis guns, and a great sweep of sky has been tracked out with white shrapnel clouds following our flying squadrons engaged hotly with hostile machines. One cannot follow the progress of these aerial battles; it is only rarely that one can distinguish enemy aircraft from ours except by the cloudlets of our anti-aircraft barrage. But far and high one sees the daring specks chasing through the blue of the sky, touched sometimes by sunlight, so that for a moment they are all golden or glistening or white as snowflakes, and down comes the low growl of the engines and the little hammer knock of the Lewis guns.

'The other day I had to crouch with the gunners below a bank while shrapnel bullets from our own Archies whipped the ground about, and I saw that red wings have come into the sky, for the new German fighting machines have crimson planes, so that they look like butterflies when the sun is on them. But although enemy airmen fight behind their own lines with great skill and courage, they do not come over our country in any such numbers as our men invade theirs. Our airmen go daily far back across the German lines, taking thousands of photos, engaging the enemy's squadrons, dropping tons of explosives upon ammunition dumps, rail-heads and transport. Some of them have downed six or seven Germans in single combat, a few have accounted for many more, and go off again as though on a grand adventure. Yet they know the risks and fortunes of war. They cannot have all the luck all the time. When their turn comes it is quick to end, or if hit and left alive they do amazing things up there in the high skies to save the final crash. Day after day these episodes are repeated, and many machines and officers do not come home. But when another

dawn breaks our air squadrons rise again and fly over the storm of battle-fields and I see them on the wing over Arras and away. The groaning of their engines is always the accompaniment of the battle down below.'

Although every phase and detail of land and sea operations in what was always called the Great War have been examined and analysed in many books it seems that the historians of warfare have little understanding of the tremendous part aircraft played. Certainly a romantic glamour has attached itself to fighter pilots whose spectacular affrays hit headline news – but it was the day in and day out work of reconnaissance aircraft which counted. Without them the commanders in the field were blind. For the first time in the world's long history of bitter fighting, the other side of the hill could be seen; every movement of the enemy made clear; every German battery pin-pointed; every new trench recorded by camera; every concentration of grey-clad troops spotted far behind the lines; the convoys gunned; the railway yards disorganized by bombing. The physical strain of flying hour after hour through barrages of gunfire produced intolerable strain.

In *The Fledgling*,* a one-time F.E.2b observer, Arch Whitehouse wrote: 'When we had any visibility at all, we booked an ungodly number of hours in the air. We flew, slept, flew, slept, and then flew some more. We never knew what conditions we would find over the field when we returned. We staggered back and forth to our machines too tired to eat. No one spoke, no one complained, no one argued. We just went through the movements like clockwork dolls.' And staring down from his nose cockpit at the murky grey of Belgium he thought: 'Flanders fields! I reasoned that poppies might have grown there at one time, but right now nothing grew. Water, mud, swamp-land – stitched with man's pathetic efforts to build up parapets and revetments. Dykes and canals, battered and broken by shell-fire, drooled their turgid waters, flooding vast acres for men to fight over – and drown in. Shells crashed with dull detonations and marked their scores with inky blobs of oily smoke. Our planes bounced unevenly through the mounds of concussion. Mysterious three-cornered rips appeared in the wing fabric. I pointed them out to my pilot, but evidently they meant nothing to him.'

If co-operation between pilot and gunner was a matter of life and death, so it was with employer and employee in their industrial relations at home. In June the Whitley Committee issued its report on Industrial Conciliation, for it was ominous that employer and employee in the imagination of Marxist Socialists had become capitalist and worker at war with each other. A National Industrial Council operating through Regional Councils and Works Councils with representatives from each group was therefore proposed in a determined effort to get both parties acquainted personally with each other and thus promote a national social consciousness of better order. To the factory worker the man who supplied the finance, and organized and managed the factory was a war profiteer grinding them down, and no

*Published by N. Vane.

amount of discussion could make them understand that every manufacturer was caught in the net of the Excess Profits Duty. Geoffrey ffiske, manager of Boulton and Paul's aviation department which was heavily committed to big production of Camels, was encountering typical difficulty with his woodworkers whose traditional outlook refused to accommodate to war-time urgencies and the vital need for every operative to turn out more work than under peace-time conditions. The Engineers Union had long recognized piecework as giving a fair financial return, but the woodworkers, who predominated numerically, would have nothing to do with it, although working side by side with the fitter-engineers and each dependent on the other's output.

Women proved quickly adaptable to many zealously guarded trades, and made a great contribution to the war effort as well as securing their emancipation. Here propellers are being hand finished at the Bristol factory.

'The very first thing that a worker is bound to question,' ffiske wrote in a shops memorandum, 'is why are our employers so anxious that we should work piecework? Are they so generous that they are giving us something and getting nothing from it? No, of course not!' So he gave an example of the cost of propellers where 50 men for a 60-hour week at 1s an hour day-work rates cost £150 – to which must be added the same amount for overheads. As each propeller took 25 hours, this meant 120 could be finished for £300 or £2 10s each. But on piecework although each man could make as many propellers as he wished in a week, he would be paid on a basis of 30 hours instead of 25. Thus if he finished a propeller in 20 hours, which was well within a skilled man's capacity, instead of the shop making 120 propellers there would be 150 – and at 30 hours pay each the cost was £225 to which was added the same £150 overhead as before, totalling £375 expenditure, yet the 150 propellers still cost no more than £2 10s each, though each man would take home 50 per cent more than his previous pay.

But no, the woodworkers feared that if their earnings went up piecework prices would be cut, although it was illegal to do so under the war-time regulations; or that if they did a job in less time it would merely result in the employer's profit; or that after the war they would still have to do it in the same time for less pay – and in any case their health would be ruined

from overwork! They closed their eyes to the fact that national revenue had increased from a pre-war figure of £200 million to £638 million.

A great air raid on 25 May gave momentary impetus to arguments for increased bomber production for retaliatory measures: but the Air Board was not convinced that big bombers paid. Twenty German Gothas had made the first-ever daylight raid, and people had been slow to realize the danger for they had gone into the streets to watch the high specks glittering in the sun, resulting in 200 casualties. It dramatically renewed the threat of German intent to terrorize the population and dislocate production.

In the House of Commons, Winston Churchill was attacking the Air Board. He said that the Admiralty had stifled it, and members had been confined to petty and trivial details. After a great row between Lord Curzon and the Admiralty new arrangements were made with Lord Cowdray in charge, but they were still half-hearted, still imperfect, still vitiated by serious flaws of administrative principle. 'Never at any moment since the victory at the Marne,' warned Churchill, 'has the situation been more serious than at present. But for the entry of the United States in this war no prudent man could have said that the issue was finally settled, and that the questions which remain were only questions of duration. As it is, there must be a most formidable and oppressive situation before us, and there must be the most vehement effort, the closest co-operation between the Government and the House, and between the House and the Nation in the terrible months of war which are coming, months more terrible than we have ever experienced. It is only by the highest wisdom and the utmost daring and the utmost comradeship that we can come through the struggle safely.'

Among the enlightened there was widespread criticism of over-expenditure and over-staffing of government departments. Temporary civil servants and Service administrators were increasing as though to match the fighting Army itself. The clerical staff of the Ministry of Munitions alone had gained a hundred thousand in two months. Everywhere offices were being commandeered. Within two years the Government had acquired eight large hotels in London, two Clubs, a town hall and very many lesser buildings for offices. Huts were springing up in the Royal Parks, and there was even talk of the Serpentine being drained for yet more office space. Of proper direction, discipline and authority, there seemed none in civil life.

To the aircraft industry the appointment of Brig-Gen W. S. Brancker as Deputy Director-General of Military Aeronautics was genuinely welcomed. The debonair, monocled 'Branks', as he was known to his friends, had first been drawn to aviation when Bristol Boxkites were demonstrated in India in 1911, and on returning to England he took his aviator's certificate at the Vickers School at Brooklands in June 1913 – but was a most erratic pilot! A commentator said of his appointment: 'It is to be hoped that General Brancker's immunity from accident may continue, so that in due course his present appointment may lead to still greater developments in the RFC, and still greater responsibilities with accompanying promotion

in substantive rank for that officer himself.' His bad landings were proverbial, for he merely aimed his aeroplane at the ground and it was a matter of luck whether he hit it hard or flattened out 20 ft too high. But he was one of the world's finest military organizers, and he had that tremendous dash and *élan* which could carry matters successfully to his target.

Major Baird, the Secretary of the Air Board, in defining its duties and relation to the aircraft Trade, said: 'The Admiralty and War Office concert their respective aerial policies in consultation with the Air Board, and the Board decides the extent to which it is possible to meet their departmental programmes. The Air Board selects and is responsible for the design of the aeroplanes and seaplanes and for their engines and accessories; it furnishes approved plans and specifications to the Controller of Aeronautical Supplies, and to the Ministry of Munitions which is responsible for their production. Design is a function of the Air Board itself, and it is the business of its Technical Department to settle designs of aircraft used by the two Services, although that does not mean that it actually designs the aircraft. The designers of the manufacturers of this country are supplied with lists of the specifications, and their corresponding designs are received by the Technical Department, checked and calculated and considered in the light of the best technical experience available. Experimental machines are then ordered for trial.

'Head of the Technical Department is Brig-Gen Pitcher – a man who has commanded both CFS and an operational Wing, and is in close touch with the requirements of pilots at the Front, and knows what the technical and manufacturing difficulties are from the viewpoint of the man who has to keep aeroplanes operational under war conditions. His Deputy Controller is Capt Groves, RN, who is a Wing Captain in the RNAS, and has had considerable experience both at the Admiralty and in Command of a Naval Wing abroad.

'One of the chief functions of the Technical Department is to arrive, as far as possible, at a common specification and standardization of machines used by the Army and Navy. Previously, for no very apparent reason, machines of precisely the same type used by the RNAS differed from machines of that type made for the RFC: consequently interchangeability was impossible. Nevertheless I do not wish the House to have the impression that we are endeavouring to standardize machines on a large scale, because nothing could be more fatal – for vast quantities would then be out of date, and you would be better off with one-tenth the number of up-to-date machines. Production in quantity and production of experimental machines are quite separate things, and nothing retards production on a large scale more than insisting on a machine being put on a productive scale before you have got it entirely satisfactory for use. A society of manufacturers had been formed, and both through them and through individual manufacturers the Technical Department keeps in closest touch with the Trade. It is hardly possible to go to the Department now without

finding manufacturers and designers in daily touch with the officers of the Department.'

One of the first results of the new planning was full Service consideration of the aircraft types likely to be required for the next phase of operational requirements. It resulted in twelve specifications for fighters, reconnaissance aircraft, bombers, seaplanes, and flying-boats. But though the road was becoming clear to the designers of airframes and engines, educational work among the still steadily rising tide of sub-contractors required first priority if enormous production was to be assured in minimum time. Many had to be educated to a new outlook, for the refinements of aircraft safety requirements were utterly foreign to their previous experience.

A lecture by Lieut-Col R. K. Bagnall-Wild, now Director of Inspection, on *The Use and Abuse of Steel* brought home some of the risks which were being run through inexperience. Many firms engaged in manufacturing aeronautical components had practically no knowledge of heat treatment of alloy steels, for it had been customary to put any such process in the hands of any glorified foreman blacksmith brought up on wrought iron but knowing little of mild steels, and the time-honoured process was to heat to cherry red or even hotter, and then leave to cool. Until recently very few firms, except in the Sheffield area, possessed heat-treating appliances, but there was now general difficulty in obtaining men with requisite knowledge of such treatments. 'It was quite hopeless for a firm to provide a heat-treating plant with the latest type of pyrometer,' warned Bagnall-Wild, 'and then sit down and allow a semi-skilled man to do the rest, for a few degrees either way could spoil a good steel.'

He said there was also delay in production, waste of material, and financial loss through lack of metallurgical knowledge on the part of some designers. Many manufacturers had not realized that alloy steels required

The second Blackburn G.P., sometimes designated S.P. or Special Purpose seaplane, was powered by two opposite-handed 190 hp Rolls-Royce Falcons, was structurally stronger than the prototype and lateral control was increased by lengthening the top ailerons and adding ailerons to the lower wings.

more careful handling than carbon steel. Rough machining prior to heat treatment was an instance because jagged edges and sharp corners were often left where cracks developed on heat treatment. Invariably the steel was blamed, next the heat treatment, and finally, the truth dawned that it was due to inadequate workmanship.

In the complexity of vaster and vaster organization, confusion often grew worse confounded. New firms were instructed to send details of purchasing requirements to the Air Board who then told them where to place orders, but they had the alternative of sending copies to the Air Board of all the orders they had placed. With studied irony the editor of *The Aeroplane* drew attention to a case where a firm ordered nuts from a manufacturer with whom it habitually dealt, and received them in a few hours. Ten days later the nut-maker heard from his customers that they had been instructed by the Air Board to withdraw the order and send it elsewhere. Said C. G. Grey: 'Presumably the aeroplanes for which they were required would have been delivered ten days later if the nut-maker had not in his innocence disobeyed the Air Board's injunction as to supplying without instructions. Though the estimable gentlemen in high places on the Air Board are reputed to be eminently successful businessmen, the buyers for the big aircraft firms, and the managers of smaller firms who do their own buying, probably know just how and where to buy rather better than do minor officials of the Air Board. Some buyers are paid quite large salaries because of their knowledge of sources of supply, and it seems a trifle absurd to turn them into mere clerks with nothing to do except fill Air Board forms or send requisitions for parts to the Air Board, while many young officials, quite without experience of sources of supply, struggle manfully to do by sheer weight of numbers and multiplicity of official documents just what any one of the said buyers could do with a typewriter, a telephone, and a few telegraph forms. Sir William Weir, the Controller of Aeronautical Supplies, can find many other instances if his duties permit him time to investigate. He will doubtless recall a very brainy effort made in the North, quite early in the war, to organize from a group of firms an output of some hundreds of aeroplanes per week, and will doubtless be able to verify a statement made recently that after well over a year's striving the output has not exceeded 10 per cent of the projected figure.'

Difficulties universally were worsened by the uneasy sense that workers in every industry were dangerously restless, and that as a result output was in any case precarious. It might well stop altogether unless everyone was careful. This high summer the engineers had been striking again, and arrests were made under the Defence of the Realm Act. A threatened railway strike was averted only by Sir Albert Stanley's promise that government control would continue after the war long enough for adequate reconsideration of the terms and hours of work. In the midst of it all a furious storm arose in the Commons, leading to heated argument all over the country, when it was learned that the Government had granted passports to Ramsay MacDonald and Jowett to attend a great International

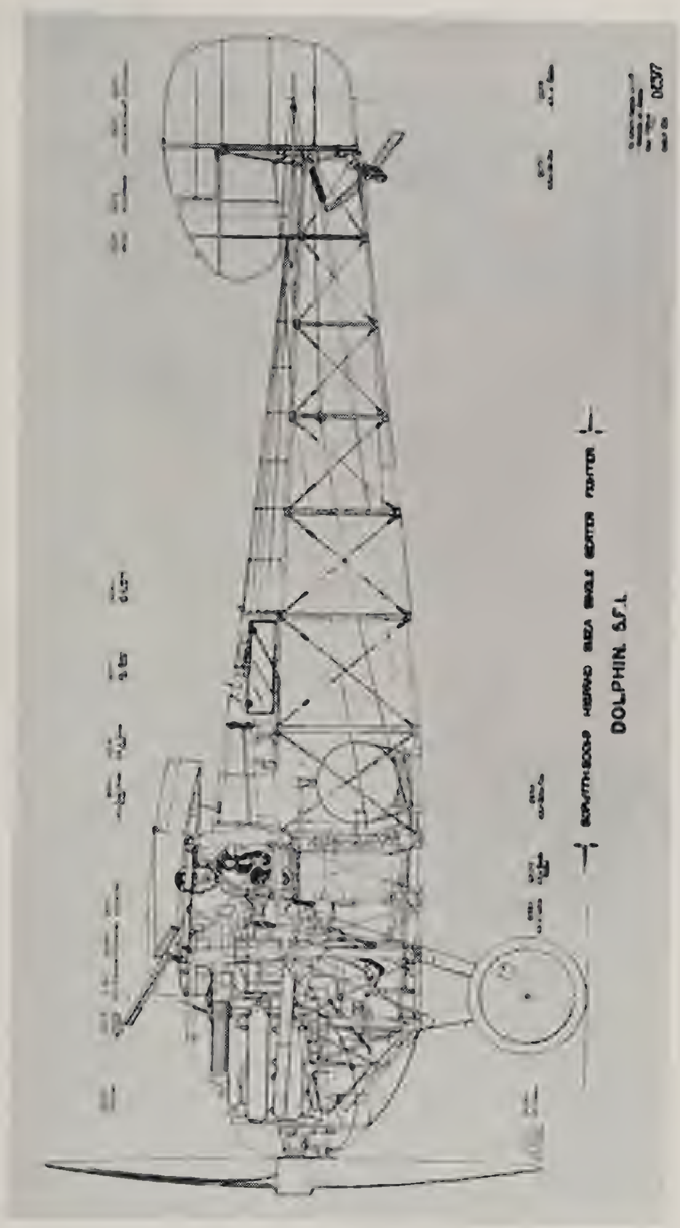
Socialist Congress at Stockholm in September. The Seamen's and Firemen's Union, on the score of danger their men were already facing from submarines, refused to allow any British ship to sail with Labour Party members to a Congress which would include delegates from Germany. However, Arthur Henderson attempted to persuade the Union that these British representatives ought to go as it would enable the Allies to present their case to the enemy and secure mutual understanding, and he managed to achieve majority support for this from the Labour Party and Trades Union Congress, but it led to controversy with the Prime Minister and Bonar Law who had been to Paris for discussions with representatives of French Labour, and the personal impasse led to Henderson's resignation.

Fraught though the lives of merchant seamen were, it was beginning to be clear that the great rise in ship losses was not going to end in our national destruction, though it remained very necessary to keep firm control of food supplies and costs. Lord Rhondda had succeeded Lord Devenport as Food Controller, and immediately initiated a policy of price limitation for cattle, bread, and potatoes, and brought grain mills under national control. He next appointed Sir Arthur Yapp as Director of Food Economy, and the approach to rationing took more earnest form with price policy organized through local Food Committees, sugar being rationed, and all householders having to register with a particular retailer to ensure direct distribution and certainty of supplies. These things added to the dreary sense of war, though its brutal impact still was shielded from civilians to whom the greatly increased availability of money was leading to widespread spending on entertainment and possessions.

9

The next German list of British aircraft which had fallen into their hands revealed 22 Sopwith Pups, 20 Nieuports, seven Spads, five S.E.s, five Camels, four Sopwith 1½-Strutters, four F.E.8s, four R.E.8s, two B.E.2es, two B.E.2cs, one F.E.2d, one Vickers Fighter, one Martinsyde, one D.H.2, one two-seat triplane, and one Sopwith Dolphin.

Inaccurate though the list may have been, it shows that at this point fighting greatly depended on the already outclassed Pup, though Camels and S.E.5s were coming in as replacements. The Sopwith triplane two-seater is mentioned as having a Scarff ring for a gunner astern the pilot, so it is just possible that it was the L.R.T.Tr. on Service trials. A surprise is the new Sopwith Dolphin. It was Herbert Smith's major design essay. 'He began it while I was designing the Camel,' said R. J. Ashfield much later. 'His first aircraft was the 1½-Strutter, followed by its bigger bomber and torpedo derivatives, then the B.1 and T.1, Dolphin, Snipe, Salamander, several fighter variants, the transatlantic contender, and the Antelope.' Ashfield undertook the Rhino and the Hippo subsequently to his earlier types. 'Smith and myself now each ran an independent small "fire brigade" design staff, whose task was to get prototypes built as quickly as possible



Original Sopwith detailed drawing of the production Dolphin.

With similar back-staggered wings to the Dolphin, but 6 ft greater in span, the private venture two-seat Sopwith Hippo was no beauty, but gave the pilot better view by locating him in front of the wing thus upsetting the air flow. (*Fleet Air Arm Museum.*)

with any kind of drawings, and by collaboration with Len Pollard of the Experimental Department.'

The Sopwith B.1 which preceded the Dolphin was a slightly stretched version of the 1½-Strutter, using two-bay wings of 38-ft span, and the fuselage extended by some 2 ft to accommodate a 200 hp Hispano-Suiza. Trials in April carrying twenty 28-lb bombs credited it with the excellent speed of 119 mph at 10,000 ft, and a probable 128 mph at ground level, though the Flight Test Section at Port Victoria reported: 'This machine was tail-heavy with full bomb load, and nose-heavy when light in spite of full tailplane adjustment. Considerable left rudder is needed at full speed, and this combined with a longitudinal heaviness made the machine tiring to fly. Controllability in the air and on the ground very good.' In fact it was promising enough to use as the basis of a three-bay increased-span torpedo-carrier.

The Sopwith company's interest in torpedo-carrying machines was necessarily subordinated to the urgency of fighter production, but Commodore Murray Sueter had always been their firm supporter, and before the war, in conjunction with Lieut Douglas Hyde Thomson, RN, had patented a system of direct suspension of a torpedo from the fuselage – though Horace Short's method of fitting it to an arched float axle was found more practicable because it required a lower lift to attach the torpedo. But latterly, with bigger and heavier torpedoes, it seemed that Murray Sueter's method applied to landplanes would be necessary in order to give tail clearance to the torpedo. Before his posting he had written to Sopwith as follows:

Most Secret Admiralty S.W.

TORPEDO-CARRYING AEROPLANE

Will you please go into the question with as little delay as possible *re*: Torpedo-carrying aeroplane with 4 hours fuel and pilot.

(1) To carry one 1,000 lb locomotive torpedo.
(2) To carry two 1,000 lb locomotive torpedoes.

Torpedo aeroplane will probably be discharged from a catapult, giving the machine an acceleration of 90 f.s. in 60 ft.

Details of experiments with a 225 Short seaplane are attached.

(Signed) Murray F. Sueter 9.10.16

An Appendix revealed that when taking off from the ex-Cunarder *Campania* of 20,000 tons and 22 knots maximum speed, the Short rose from its free-running launching trolley in 106 ft against a relative wind of 30 knots, and in as little as 47½ ft in a wind of 40 knots.

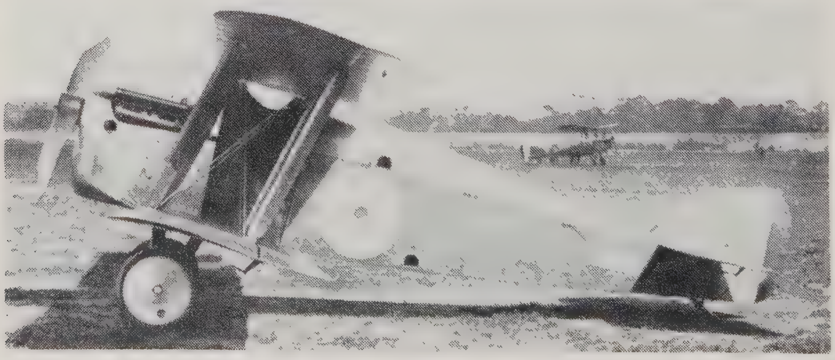
Murray Sueter recorded in *Airmen or Noahs* that: 'I invited Mr Tom Sopwith to come and see me at the Admiralty, and asked him to consider this question of building a torpedo aeroplane. Sopwith was a great constructor, and never failed in anything I asked him to undertake. He thought my proposition was very stiff, as it meant building a light aeroplane round the Whitehead torpedo, and he had better think it over. He went carefully into my request, and finally produced the torpedo aeroplane which he named the Cuckoo. When this special aeroplane was nearing completion, I was ordered to Southern Italy, and nobody took much interest in a torpedo machine at that time. However, one day Wing Commander Longmore was visiting the Sopwith Works, and saw the Cuckoo triced up

Successful torpedo dropping by the Arab-powered Blackburn-built Sopwith T.1 Cuckoo at the Torpedo Aeroplane School of East Fortune, Firth of Forth, in July 1918. The Cuckoo inspired confidence among pilots and could be ditched without difficulty. (*Fleet Air Arm Museum.*)

Altered by Port Victoria engineers from a single-seat Sopwith B.1 to a two-seat Fleet Reconnaissance, the initial Grain Griffin was a compromise considered worth re-engineering into the form illustrated, but still required control modifications and was not put into production. (*H. Busteed.*)

to the beams of one of their workshops, and, pointing to it, asked why it was there. This led to its immediate despatch to the Isle of Grain, where it was vigorously flown in July 1917, fitted with a 200 hp Hispano-Suiza. As a result an order was placed on August 16th for 100 machines to be built by the Fairfield Shipbuilding and Engineering Co Ltd, of Glasgow. Basically it was a three-bay version of the B.1 bomber which at this point was being converted into a Fleet reconnaissance two-seater, fitted with wireless and folding wings.'

When Busteed and Sayer received the B.1 at ECD Grain for conversion they were not very enthusiastic. No radiator was delivered, so it was impossible to fly the Sopwith although the job was considered urgent. Conversion was full of snags. The fuselage was too narrow to carry wireless, and the interplane struts so located that they fouled the tailplane when



The Sopwith Dolphin prototype, shown at Brooklands, had a deep fuselage with bulky car type radiator, deep top decking, and small fin and rudder. The Dolphin went to France for operational trials on 13 June, 1917. (*Imperial War Museum.*)

folded. The D.O. reported it would be quicker to design a new but similar machine as modifications could only result in a botch. The British compromise was taken. Grain was instructed to convert, but allowed to design a new machine concurrently.

Conversion necessitated reducing the span to bring the struts clear of the tail on folding, but when finally tested the altered machine, with its additional cockpit, had lost most of its performance, and it also became clear that in its original form the ailerons must have been useless. However six of the Grain redesign had already been ordered, known as Griffins. A set of longer wings with rearranged spar bays giving increased overhangs was rushed through and fitted to the original Sopwith fuselage, together with wheel aileron control instead of stick, and on test the machine was found to have substantially regained the lost performance, though lateral control remained poor and led to fitment of balanced ailerons.

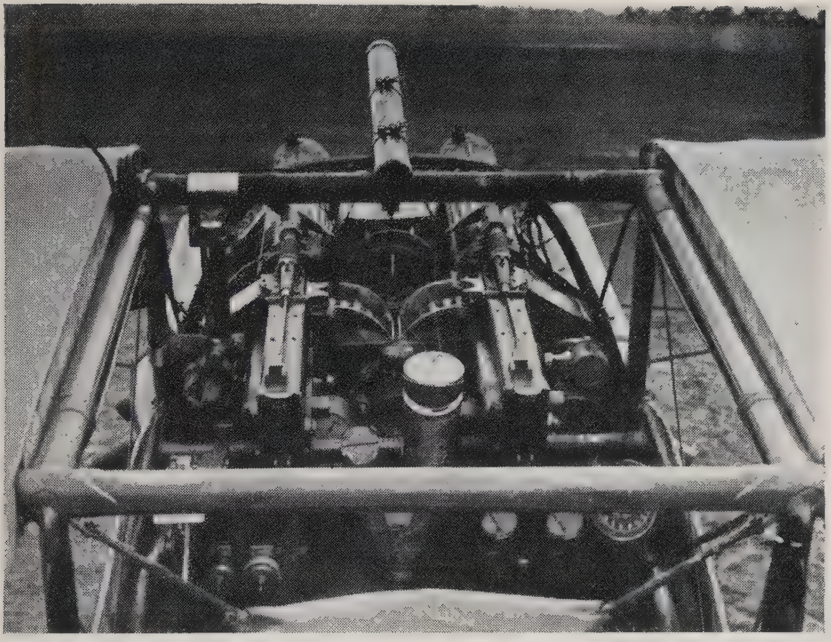
The second Sopwith Dolphin was a modification of the prototype with side radiators enabling a more pointed nose with better view, and smaller fin with horn-balanced rudder. There were cut-outs in the lower wing roots to improve view. (*Imperial War Museum.*)

Herbert Smith had applied this experience of multi-bay biplane design to the evolution of his new fighter – the 5F.1, later named Dolphin, characterized by the backward stagger de Havilland had so daringly initiated. It was a considerably bigger machine than the Camel, and again reveals the Sopwith technique of superimposing a new design on an old one: inevitably Smith's 1½-Strutter. The fuselage profile from lower rear spar to stern-post is the same, the rear leg of the undercarriage picks up the same attachment point as the rear leg of the 1½-Strutter, and the projected combined chord of the Dolphin's back-staggered wings matches the single chord of the 1½-Strutter. However, the result was utterly different in appearance, due to abrupt truncation of the fuselage to take the Hispano and its bulky car-type radiator, and the top decking was particularly deep for a Sopwith design, largely to give a high seating position for the pilot amidships under the open centre-section, close to the engine.

The significance of German mention of the Dolphin as a casualty in July is that it must have been a prototype, for the first contract for 500 Dolphins was only given to Sopwith on 29 June, and the Darracq Motor Engineering Co was given the next on 13 July. After satisfactory trials by Harry Hawker at Brooklands the unmodified prototype went briefly to Martlesham Heath, and then was flown to St Omer by Capt Henry Tizard, where Trenchard's renowned aide-de-camp, Maurice Baring, recorded its arrival on 13 June – less than three weeks after clearance by the Sopwith Experimental Department. No record has been traced to confirm its loss in action, but it is not impossible. A modified prototype was already in hand for incorporation of modifications proposed by Harry Hawker, Martlesham, and the Service pilots. Rudder control was somewhat heavy, particularly in restraining directional out-of-trim forces, so the original 1½-Strutter-type fin was halved in height and a large unshielded balance fitted to the top third of the rudder-post, and the rudder increased in chord. Forward view in the prototype was particularly poor when landing as the pilot had to squint under the wing at an obtuse diagonal because the top cowling was so bulky; whereas the conventional S.E.5 pilot location gave a better diagonal despite that machine's relatively bulky nose. Herbert Smith therefore steeply sloped-down the top cowling, which then exposed the fore barrels of the twin Vickers guns, and as in any case the machine had an extreme forward C.G. owing to engine and pilot disposition, the car-type radiator was abandoned, the under cowling swept steeply upwards to the propeller hub, and a surface radiator incorporated in the root end of each upper wing; here the cooling proved inadequate, and on the third prototype they were relocated as narrow chord vertical elements each side of the fuselage abaft the cockpit; possibly this blanketed the tail surfaces, for the rudder was next made somewhat taller, the fin enlarged, and its sweep taken upward to shield the rudder balance which now had a right-angle leading edge instead of a semicircle. Twin Lewis guns were additionally mounted on the forward cross tube of the centre-section cabane, the four guns giving greater fire power than any other Allied or enemy fighter.

When the rising Canadian air ace, Capt Bishop, had his Nieuports, of which he was so enamoured, replaced by Dolphins, he was quickly disenchanted, and later recorded: 'They were pigs. Though fast, they were very unmanoeuvrable. Pilots were dismayed because their head projected through the open centre-section, and they felt trapped if the machine turned over and caught fire.'

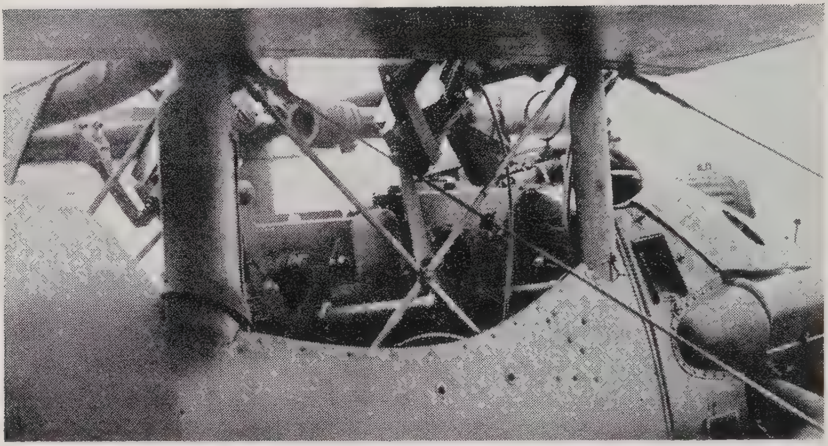
As a youngster in 1917 I had special access to the School of Aeronautics at Reading, and on a number of occasions visited the large Co-operative 'Jam Factory' on the outskirts at Coley, where a small aerodrome had been made from two large meadows alongside the Kennet. In the main hall every type of current operational aeroplane was housed, often in partly stripped condition, to familiarize pilots, observers, and maintenance crews with the machines they would use. Apart from their thrilling appearance



The Sopwith Dolphin had a fearsome cockpit which was a death trap in a nose-over, but the intention was to get the pilot high for fighting view above the top wing, and engine and pilot were located close together to reduce inertia and aid response. (*A. R. Boeree*.)

as aggressive fighters, the Camel and Dolphin could be identified as Sopwith productions by sitting in the cockpits. In both, the pilot was located as close as possible to the engine with no real bulkhead, but the Camel had an aluminium sheet as a token safeguard against fire. A pungent and thrilling smell of acetone dope and copal varnish greeted one. In the Camel the pilot sat relatively low, with twin gun-breeches dominating the little instrument panel and leg-room obstructed by large-diameter aluminium carburation inlet tubes sweeping across the cockpit and hiding the rudder bar. Their open ends projected outboard to gather air which was channelled through a mid-connection to 'bloc-tube' carburettors, on the rear crankcase, to which the crystal-clear but low-grade petrol of those days was fed from a large tank behind the pilot – causing increasing nose heaviness as it emptied – through a fine adjustment to a jet one side of the carburettor, controlled on the other side by a variable-throttle opening and jet needle. It required particularly careful adjustment of the fine mixture device to ensure that the right proportions of petrol and air were employed, and it was appallingly easy to stall a rotary engine with either too rich a mixture or too weak, resulting in many a disastrous take-off.

I was even more impressed by the Dolphin. It seemed the very epitome of the designer's art. But again the pilot was sandwiched between engine and petrol tank in a clutter of gear and instruments, and the open framework



Close up of the Sopwith Dolphin cockpit, showing gun and gun-sight. (*A. R. Boeree.*)

of the centre-section was so close to the fuselage decking that not even a small boy could have wriggled out if the machine tipped on its back. Seating posture was upright, as in the Bristol Fighter, with knees sharply angled to get leg-room for the rudder bar. I could barely see the top of the nose coaming, yet the head of a tall pilot would slightly project, though his line of horizontal vision went just beneath the forward tubular spar. Service criticism presently led to fitment of vertical triangular pylons each side of the centre-section connected by a cross-bar some 18 inches above the wing, so that if the machine turned over the clearance given by this structure might enable a pilot to crawl out: other Dolphins used for night flying had two steel half-hoops, like inverted wing-tip skids, mounted above the inner bay struts. Neither fully satisfied, and eventually escape panels were made in the sides, though the cross-bracing must have made these equally impracticable.

10

Air fighting was becoming a matter of high organization by co-ordinated Flights rather than individual attack in the manner favoured by Capt Ball, VC, who had fallen victim to German guns on 7 May while flying his S.E.5 with which he had become reconciled though still pinning hope on the uncompleted A.F.B.1. Important development in armament efficiency was now responsible for the new lethal nature of aerial attack. This was the novel gun synchronizer, known as the C.C. gear, devised by Gogu Constantinesco, assisted by Major G. C. Colley, who in January had filed a complete specification for *An Improved Method and Means for Actuating Gun Triggers*, though the patent was first applied for on 14 July, 1916. It stated: 'By means of a series of periodic changes of volume and pressure travelling along a liquid column, the changes of volume and pressure being of harmonic form . . . impulsive waves obtained by the rotation of a cam driven by an aeroplane engine are used for the purpose of firing a machine-

gun and so timing the shots that they always pass between the propeller blades.'

This did away with the backlash and complicated linkage of mechanical types devised by Challenger, Kauper, and others including Fokker. The engine drove a hydraulic generator connected to a trigger motor by a pipe filled with paraffin-oil normally vented via a secondary pipe and valve to a cockpit reservoir which incorporated a pull-up hand pump to create stored pressure acting on the valve block. Operation of the valve by Bowden-connected lever on the control column closed off the reservoir and admitted pressure oil to the generator from the charged pump, and an impulsive wave was created by the generator cam operated from the engine, which piston-operated the machine-gun trigger – firing the gun every half revolution of the propeller, unless this was faster than the rate at which the gun was capable of firing, when the trigger bar would move without firing the gun to prevent hitting the propeller.

The earliest machines fitted were the new D.H.4s of No. 55 Squadron which arrived in France in March 1917, but not until four months later did the first Sopwith Camel arrive with twin guns operated by this mechanism. Inevitably there were initial teething troubles, largely due to unfamiliarity of mechanics with hydraulic systems; but there were secondary difficulties through belt feeds limiting duration of gunfire, and only cured when the Prideaux disintegrating interlocking link was devised a few months later, using an expendable belt in which the metal links fell away from an ejector chute as the shots were fired. Accuracy was increased by supplementing the standard ring and big bead, adapted from conventional rifle sights, with the Aldis optical sight in the form of a small telescope having sighting marks on eye-piece and lens. Yet it was not armament alone nor sensitively precise

Rotaries could be spun by one man but starting more powerful engines, such as the Hispano-Suiza in the Sopwith Dolphins, required a team to pull it over compression, and on muddy ground this could be tricky. Note the wheel chocks. (*Imperial War Museum.*)

One method of overcoming the restricted field of fire for the gunner in the front cockpit of an R.E.7 was a hole cut in the centre-section so that the gunner could stand and fire a Lewis gun on a spindle mounting above the wing, but it ruined the aerodynamics. (*D. F. Woodford.*)

control which made later Camels so effective but the fact that at last the pilot was strapped tightly down with shoulder straps which prevented him lifting from his seat if he pushed the stick too hard forward or turned upside down. All earlier machines had only a safety belt which gave no vertical restraint and led to a number of crashes. Tall Capt Oliver Sutton realized the peril and devised a simple X-bracing of webbing with adjustment for forward restraint and a simple safety-pin quick release. No longer would a ground nose-over result in concussion against the gun-butts, and henceforth fighter pilots could tumble their Camels and S.E.5s in the air at any attitude, feeling they were part and parcel of a unified winged creation.

Another view of the centre-section cut-out and spindle-mounted gun of an R.E.7.

A graphic picture of fighting in the air is drawn by Arch Whitehouse* as gunner in his new R.E.8: 'Aircraft were charging from all angles, their tracer rounds drawing a crazy-quilt design against the sky. Two collided, clutched each other a few seconds, then tumbled earthward in slow, sweeping spins. Broken wings and struts flashed and glinted like brassy items carelessly discarded. Wreckage twisted and turned, and trails of smoke scratched crayon marks down the sky.' There was no escape by parachute when the bullet found its lethal mark. That was reserved only for gun spotting observers braving it out in the baskets of defenceless sausage balloons poised like fat slugs dotting a ragged line each side of the battle-

Kite balloon observers had deep wicker baskets to absorb bumping when hauled in. When airborne their insurances were the Calthrop parachutes in their bulky containers slung from the rim. Note telephones and map rest. (*Imperial War Museum.*)

front. They had their Calthrop *Guardian Angel* parachutes. It was not disinclination of high authority to give aeroplane crews a similar chance to escape, but primarily a question of weight. The basic struggle in aeroplane design was to secure maximum rate of climb and ceiling against the limitation of engine power, and the only solution was light wing loading. Every pound saved was vital. A parachute, with container and static line, weighed about 15 per cent of the entire disposable load of armament, pilot, fuel, and oil carried by the Pup. Most pilots judged that a preferable life-saver was in expending that weight on another gun and more ammunition, as shown by the S.E.5 and Dolphin, for with a single gun they had only 50 seconds total firing before ammunition was expended. Even had more disposable load been available, only twin-engined bombers were big enough to afford space provision for the bulky stowage essential to the Calthrop.

*In *The Fledgling*.

Patent after patent had been granted to the inventor for various improvements, and he was well aware of a pilot's enormous difficulty in jumping from a crashing aeroplane when he was attached by static line to a parachute stowed a few feet away, either within the fuselage or in a container beneath. It had been performed by Capt C. F. Collett, RFC, on 13 January, 1917, when he jumped from a B.E.2c at 600 ft as a finale to 20 drops with dummies; but in general pilots did not seem enthusiastic, and even crews of kite balloons were not keen to trust their lives to a parachute. Only two weeks after Collett's jump, Capt R. M. Groves, in a Minute to the Air Board, wrote: 'The heavier-than-air people all say that they flatly decline to regard the parachute in an aeroplane as a life-saving device which is worth carrying in its present form.'

Yet had parachute escape been universally considered essential, undoubtedly a solution would have been found more quickly and steps taken to educate air crews in parachuting. As yet it simply had not occurred to Calthrop, or even his most zealous supporters, that a pilot could wear his parachute in a pack and make a free drop until a self-contained unfurling mechanism was operated. It did not seem to be known that as early as 1908 an adventurous American, A. Leo Stevens, had jumped from a Curtiss and used a rip-cord to undo his parachute pack. Nevertheless Calthrop was contemplating use of a pilot parachute to pull out the main canopy, but it would require many demonstrations to prove reliability. Meanwhile there were too many other pressing aerial developments which were absorbing all the energies of the Experimental Flights at Farnborough, Martlesham, and the Isle of Grain. Chronologically the Great War had come too soon – just as it did for many other inventions.

Although every promising device was investigated by the Royal Aircraft Factory its scientists remained primarily engaged on correlating wind-tunnel results with full-scale application to aeroplanes and propellers. Their reports had become cautiously expressed, as though lacking the confidence which O'Gorman instilled when he led the way. Nevertheless a few useful general conclusions were emerging such as: 'There would appear to be no aerodynamic advantage in so far as maximum horizontal speed is concerned in fitting wings of high aspect ratio to a Scout, since the wings of a high-speed aeroplane should have a high maximum lift coefficient, and also a high value of L/D (lift/drag ratio) at a small lift coefficient, but there would be appreciable aerodynamic gain when climbing. However, wings of high aspect ratio should be aerodynamically efficient on a heavily loaded night-bomber of moderate speed, because high values of L/D are developed at the working values of the lift coefficient.' But there was an atmosphere of doubt even on simple things. The effect of various biplane arrangements on lift and drag could only be empirically stated, but when it came to comparing monoplane, biplane, and triplane it was at least clear that the L/D, as a measure of efficiency, dropped proportionately from 16·6 for the monoplane to 12·9 and 11·4 respectively. Even the deleterious effect on performance by cutting a hole in the centre-section of

fighters to improve visibility had not been appreciated until wind-tunnel tests with a model Sopwith Camel now showed that the L/D was worsened by 20 per cent, with a reduction of 10 per cent in lift, for an open area only 1·8 per cent of the total wing area.

Yet British aircraft, whether fighter, reconnaissance or bomber, in the ceaseless ebb and flow of temporary advantage, were matching and more often beating German performance by consistently simpler structures for minimum weight – though the German, with his semi-monocoque fuselages, welded construction, and earliest all-metal design was leading the field in advanced technical development, but to less advantage than the inevitable British compromise. When it came to controllability and response, then the British aeroplane matched British lightness of touch and quick decision, compared with the slower response of aircraft designed for the more formal Germans.

This question of handling was one of the great targets of research at the Royal Aircraft Factory – though results were not always successful, even with the latest machines backed by Farnborough research. Thus the R.E.9 was difficult to land unless there was excessive weight in the passenger's seat; despite a small tailplane and maximum elevator angle it was impossible to make the customary float if speed dropped below 50 mph when flattening out with the engine off, nor could a tail-down landing be made. Even the B.E.2c and the F.E.2b could not be dived steeply for any length of time because of the heavy push required on the control column; but they were not alone, for the Trade-designed D.H.2 was equally stable and had the same defect. The Royal Aircraft Factory was also discovering that unstable aeroplanes required a large pull at terminal velocity to keep the path from steepening, and many were proving dangerous, including so simple a machine as the D.H.6. The work of H. Glauert and S. B. Gates on such problems seemed rather heavy going after the way in which Ted Busk earlier had tackled the factors that make a stable aeroplane. Yet always there were useful by-products from current investigations, such as the degree of rake given to the tips of flying surfaces – for tests with the S.E.5 revealed it better for lightness of control to have the trailing edge shorter than the leading edge because the effect of moving a control surface predominantly increased lift on the fixed part of the wing or tailplane in front of it. Martlesham confirmed that the new S.E.5a with much squarer wing-tips was lighter on lateral control than the original S.E.5 which had a 21 degree rake.

From such mixtures of practice and theory came an important contribution where Farnborough led the way, yet we failed to take advantage of it as with so many British inventions. Much consideration had been given to methods of improving performance apart from greater power from bigger engines. Faster climb at some small sacrifice of speed by increasing wing area had been self evident but suffered the drawback of decreased manoeuvrability, so attention turned to propellers. When designed for optimum efficiency at maximum permissable rpm at level speed at a


Farnborough leads again – though clearly advantageous, the variable-pitch propeller designed for the S.E.5a was criticized because it had a hand control which might distract a pilot when fighting. (*Royal Aircraft Establishment.*)

particular height, there was loss of power when climbing due to decreased rpm and inefficiency.

As a first step Farnborough decided to produce a four-bladed variable-pitch propeller for the simple instance of the slow B.E.2c and its low-powered RAF 1a engine. A remarkably simple hub was designed in which each blade was bolted into a split shank on bearings; inside each shank was bolted an operating arm attached by a link to an external striking plate impelled backwards or forwards along the hub through a double-thrust race operated by a lever attached to the engine crankcase. Ground tests proved it amply strong at the 1,100 rpm of normal operation under a load of doubled power, and its weight of 75 lb, compared with 35 lb for the standard walnut propeller T.7448, was hopeful, though the control gear weighed 10 lb extra. Despite a certain amount of backlash in various joints, the system when tried in flight was easy to operate, and there was no doubt of the aerodynamic advantage. Although it was very obvious that the increased performance would be invaluable in battle, objections were raised because it involved use of a further control when the pilot was concentrating on shooting. The RAF decided to investigate a variable-pitch propeller for 200 hp at 2,000 rpm, although a little worried that this would increase the weight by 40 lb and thus reduce performance advantage.

CHAPTER VI

MAINTAINING THE PACE

1917 (*cont.*)

'It is mere illusion and pretty sentiment to expect much, even anything at all, from mankind if it forgets how to make war. As yet no means are known which call so much into action as a great war . . . that earthquake-like soul-shaking which a people needs when it is losing its vitality.'

F. W. Nietzche (1880)

1

THE THIRD Battle of Ypres was about to begin, and Maj-Gen H. M. Trenchard, CB, DSO, as Commander of the RFC in France, and Controller Combined Air Operations of the British, Belgian, and French, issued orders for a preliminary Air Offensive to open on 8 July. The enemy were aware of the impending storm, and although the British concentration of aircraft was over 600, including the RNAS at Dunkirk under Capt C. L. Lambe, RN, DSO, the Germans had doubled their Fourth Army's air strength opposite the British Fifth Army, and now had equal number to dispute ownership of the skies.

The great land battle began on 31 July, 1917, in an endeavour to throw off Germany's hold on the Belgian coast and crumple its right wing. Weather was bad, aiding the enemy, and once again plans went wrong, for Sir Henry Rawlinson was unable to land his special army behind the Germans' right where his troops were intended to widen the scope of the British offensive. Nevertheless the battle pinned down the enemy, so that Sir Douglas Haig was successful in preventing them from assuming initiative at a time when the French were suffering serious military trouble.

In the midst of war George Holt Thomas took forethought of the future, and lectured to the Aeronautical Society on *Commercial Aeronautics*. 'The history of aviation in this country is lamentable but glorious,' he said. 'The importance of military aeronautics is now known to us all, but nobody can say how we might have changed this war if we had taken it in time. To-night I am speaking in exactly the same strain on *commercial* aeronautics as I spoke seven years ago on *military* aeronautics, and I assert that I am speaking on as large a subject, and one of just as vital importance to the Empire.'

He forecast there would be internal airlines on a trunk route from London to Manchester and Glasgow, with feed-offs to Dublin and Belfast. Great European lines would be established to the capitals of every Continental country, including Russia, with eventual extension to India, Australia, and the USA. Expressing the money value of those war years, he calculated the economics on the assumption of aircraft having a payload of 2,500 lb costing only £2,500 each. Pilots' pay was £500 per annum, and overheads on nine aircraft would be £14,000. On that basis he showed that mail services could be established as commercial propositions. Businessmen would use aircraft to save time. 'Remember we live on an island; remember that we have always depended on the sea for our protection; and last but not least remember that we are an Empire. On all these points it is necessary to maintain a huge aerial fleet, and the proper support of commercial aeronautics will enormously assist our ends. This time we *must* be first.'

Commenting on Holt Thomas's lecture, Lord Cowdray said: 'We have to bear in mind that after the war there will be thousands of aircraft, thousands of skilled pilots, many thousands of mechanics who are a great asset to the nation. They have been splendidly trained; they have proved their work by going through the difficulties and dangers of their occupation successfully. It is essential that these men should be used in commercial aviation at the end of the war. The Government ought to help. It cannot be expected that commercial aviation can step into business that will produce 5s per mile right away. I expect government assistance will be necessary for possibly the first five or six or seven years. Imagine what that means. Yet think of the future when you can go at 100 or 120 mph instead of in a cross-country train at 20 or 30 mph. It will lengthen life in so far as it will enable us to do so much more than we have been able to do in the past.'

The Holt Thomas empire by now was vast. More than 200 Gnomes and Le Rhônes were being built each month at the Walthamstow works of his subsidiary, Peter Hooker Ltd, under technical direction of P. Gregoire, formerly chief engineer at the Le Rhône works at Lyons. A new great factory had been built, extensively equipped with the latest metal-working machinery, and the original Hooker premises had reverted to Newall gauges and the precision work for which the company had originally gained fame. Extensive development similarly enlarged the Integral Propeller factory at Hendon, where the office and works now covered 35,000 sq ft, with propeller production of 100 or more per week, using mechanical shapers instead of the painstaking hand craftsmanship of a year or two earlier, though retaining the same brilliant standard, for exact balancing was even more requisite with larger propellers transmitting still greater horse-power. Submarine warfare had also forced huge expansion of Airships Ltd with fabric workshops at Merton, Clapham, and Wandsworth, totalling 100,000 sq ft and employing 1,000 skilled hands on envelope fabrication for kite balloons, S.S. Class airships, and the large Astra-Torres types embracing the Coastal Star and North Sea Class. At Hendon the

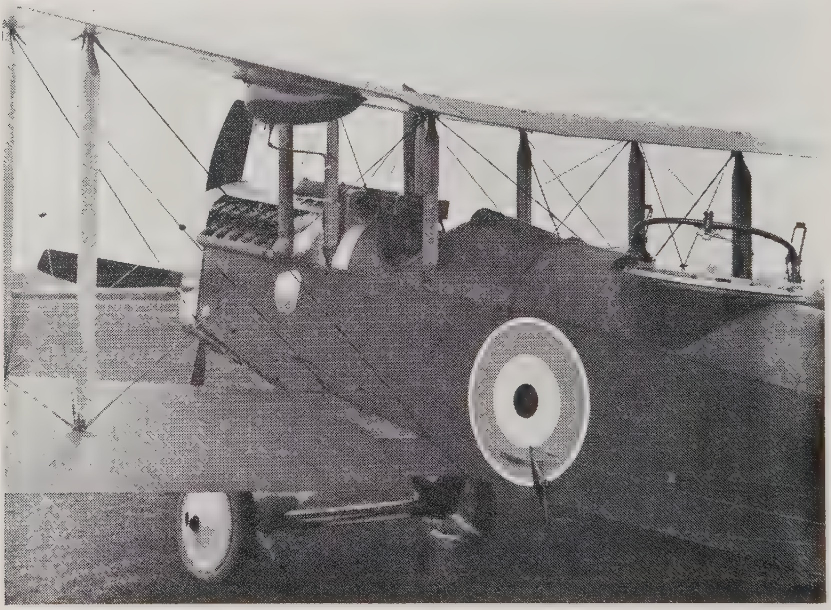
Small non-rigid airships for anti-submarine patrols were used throughout the war, the earliest taking the simplest form, using redundant Renault-powered B.E.2 fuselages as crew cars, and trunking some of the slipstream to internal air ballonets to maintain the envelope's shape after altitude change. (*Courtesy C. H. Barnes.*)

Aircraft Manufacturing Co, which Holt Thomas now began to refer to as Airco, had a splendid 4 ft wind-tunnel primarily for research on airship resistance, and there was an extensive experimental laboratory for material testing. A subsidiary rivalling Short Bros was May, Harden and May Ltd at Southampton and Hampton Wick who, under the management and technical direction of A. Harden, were now the parent firm for design, stressing, and construction of Porte's series of Felixstowe F.2A and F.2B flying-boats.

But the heart of activities was aeroplane design by Geoffrey de Havilland and his staff in their extended Airco factory on the main Edgware Road. Stressmen, draughtsmen and tracers were 70 strong, though Sam Hiscocks, now Works Manager, had just shifted the entire flying-boat design staff to Hythe. Arthur Hagg had swiftly risen to the post of chief designer. If Charles Walker was de H.'s right hand, then Hagg was his left – though never with quite the same close relationship as the stoical Walker, and brother-in-law Frank Hearle, who had at length rejoined de Havilland and was in charge of experimental work. At the instruction of the Air Ministry, they were busy on a replacement for the stalwart D.H.4, with pilot and gunner close together behind the wings like the R.E.8. The designated engine was the newly designed 300 hp Siddeley Puma six-cylinder vertical derived from the BHP, but two thousand equivalent 275 hp Fiat A-12s had been ordered as stand-by though would not be available until well into 1918.

A great daylight raid on London had been made by German bombers on 13 June, and casualties far exceeded the total of all other air attacks. The following Sunday a mass meeting, sponsored by the *Daily Express* and attended by the Lord Mayor and many MPs, including Pemberton Billing, was held at the Stoll Picture Palace in Kingsway to demand reprisals. Increasing agitation was having its effect in high places. The Air Board

decided that emphasis must be placed on bombers and attacks far into Germany. Cabinet decision was reached on 2 July to increase the number of RFC operational squadrons to 200, most of which were to be bomber units with longer range than the D.H.4, though orders for the latter were stepped up until the replacement was available.



Westland-built Eagle-powered D.H.4s for the RNAS had twin forward Vickers guns for pilot, upward view panel in centre-section, and raised gun ring for observer. Finish was outstanding. (*Westland Aircraft*.)

'At that time there were no Air Board specifications issued, so our new types arose from discussions between de H. and the Air Board – generally in the person of Colonel Beatty,' said Charles Walker. 'I would not call it technical sales talk so much as general technical discussion. What emerged was very much the de Havilland interpretation of the desires of the Royal Flying Corps.' Adopting prevailing practice, de Havilland was virtually making a redesign of the D.H.4, almost identically structured with plywood-covered forward and extreme tail portion, and a conventional braced box girder between, using wings of identical span, chord, gap and stagger. Aiming at similar empty and all-up weight, it was an exercise in relocation of crew and engine to produce the correct c.g., but success depended entirely on the greater production availability and far better fuel economy of the Puma compared with the Rolls-Royce. As the D.H.7 was a single-seat fighter design similar to the Martinsyde, and the D.H.8 was schemed as a pusher armed with a $1\frac{1}{2}$-pounder C.O.W. gun, the new machine became Type No. D.H.9. To gain immediate data a D.H.4, No. A.7559, was

modified to take a 230 hp Galloway-built BHP following production difficulty with the aluminium cylinder blocks of 2,000 Pumas being built by Siddeley-Deasy. What the inexperienced pundits of the Air Board had optimistically ignored, after Bentley's quick success in stepping up rotary power with his B.R.1 and B.R.2, was the time required to develop an engine to reasonable reliability at its designed power – though they had the cautious steps taken by Rolls-Royce as example. But de H. had his ear to the ground, and was quickly aware that Halford's engine, as redesigned by Siddeley engineers, was having trouble. If it produced less than the nomi-

In September 1917, 100 Russian pilots were being trained in England, and 50 D.H.4s with Fiat engines had been ordered by the Russian Government but were diverted to augment British bomber forces in France.

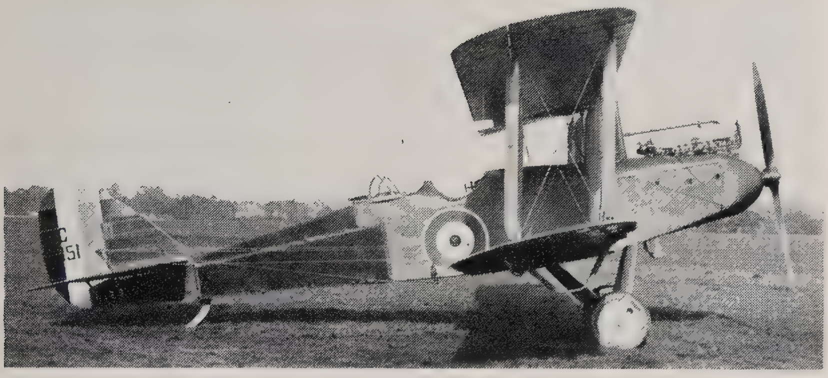
nated 300 hp, then the new D.H. day-bomber would be inferior to the 275 hp Rolls-engined D.H.4.

Halford had no say in the Puma at this stage, for John Siddeley, a small man with fiercely abrupt and disconcerting manner, brushed him aside and took personal responsibility for redesign – replacing the cast-iron cylinder heads with aluminium, and screwing liners in with a short length of thread instead of full length into an aluminium muff, as well as making many other modifications. It was a bad knock to the enthusiasm of Halford. In a lecture at the RAeS, Major G. P. Bulman said that: 'Halford had no engineering training at all, none of the academic qualifications normally expected. He was the essential creative artist, anxious always to "get-on-with-the-next", and a little too apt to leave to his devoted staff the drudgery and sweat of carrying his latest-but-one design into production. He had immense magnetic and dynamic charm, but his mind was ever busy with his engines.'

Inevitably the Puma was down-rated to 230 hp, but it was too late to cancel production, nor could current productivity of the Rolls-Royce factory be increased for the Eagle to be used as substitute. That great company would not yet sub-contract to anyone except 32-year-old Roy Fedden of Brazil Straker, car-builders at Fishponds, Bristol, for they considered other engine-builders could not attain their high standard. The dynamic Wilfrid Briggs had picked out Fedden as a particularly keen engineer who could tackle rectification and modification of a disastrously dangerous batch of Curtiss OX-5 engines which had been shipped from the USA. So satisfactory was this work that Briggs introduced him to Elliott, the key-man of Rolls-Royce, and instructed them to collaborate with production of the R-R Hawk, a six-cylinder engine which was giving considerable trouble through breaking its crankshaft. With a confirmed record of successful sub-contracting, Fedden and his Brazil Straker factory were soon entrusted with Falcon production. 'J. P. Brazil, the owner of the company, was a charming man of retiring disposition,' said Fedden. 'He did not care to become involved with "big money" such as Rolls-Royce, but pre-war had commanded very reasonable success by building machinery for the Imperial Tobacco Company and others. Under the pressure of war-time development he panicked, and sold the business in 1917 to Cory Bros., who were a big coal-distribution company. When the Ministry of Munitions tried to force Rolls-Royce to get a dozen or so other firms to make their engines, that very great man Claude Johnson took the bold stand that he would tear up every drawing and go to prison rather than agree to risk inferior skills of other companies.' Rolls-Royce had their way.

Yet production was paramount. There must be more and more engines. When it came to the Puma it was far less justifiable for Air Board administrators to think that, because Germany had successfully standardized the six-cylinder vertical, it was reasonable to copy the enemy.

Certainly de Havilland had his misgivings, for he privately informed Trenchard that the low-powered D.H.9 would have poorer performance than the D.H.4, and certainly would be unable to achieve the same ceiling when fully laden. 'I do not know who is responsible for deciding upon the D.H.9,' wrote Trenchard to Maj-Gen J. M. Salmond, Director-General of Military Aeronautics, 'but I should have thought that no one would imagine we should be able to carry out long-distance bombing raids by day next year with machines inferior in performance to those we use for this purpose at present. I consider the situation critical and I think every endeavour should be made at once to produce a machine with performance equal at least to the existing 275 hp Rolls-Royce D.H.4 and to press on with the output with the utmost energy.' When Salmond took this up with the Air Board, Sir William Weir, who was only too aware of the strangled engine situation he had inherited from earlier government policy, told him it was a case either of the D.H.9 with the BHP, or nothing. So the D.H.9 it was, but the only advantage found by the Martlesham test pilots, when



The first production D.H.9, C6051, built by Airco on arrival at Westland's aerodrome as an instructional example. There were still manufacturing and technical difficulties with its Puma engine which gave only 230 hp instead of the estimated 300 hp, but it was vital to go ahead with this day-bomber.

they came to test the D.H.4 conversion version of the D.H.9 was: 'The pilot's view for fighting is better than in the D.H.4, and it is a great advantage to have pilot and observer close together.' This was qualified with a comment that the pilot's view would be obstructed by the lower wing, which might be a serious disadvantage for reconnaissance and quite unsuitable for night bombing.

At one of the Aeronautical Society lectures O'Gorman explained the kind of impasse with which de Havilland was faced: 'The aeroplane designer in war-time prefers to work out his aeroplane so that it makes use of an engine which exists and is reliable and is likely to do him some credit at once. He is loath to study and build an aeroplane in anticipation of some projected engine not yet tried out in hope of it proving a success. He knows that there are many slips betwixt cup and lip in experimental engine production.'

Even with established engines available, it had hitherto been hit and miss whether the propeller, which was the aeroplane designer's responsibility, would efficiently transmit the available horse-power. The Farnborough variable-pitch propeller was a step in the right direction to satisfy conflicting requirements of climb and speed, but there would undoubtedly be complication and strength disabilities when it came to greater horse-power and increased rpm – for centrifugal force would create big problems in attaching the blade roots to the metal hub and mechanism. Already Farnborough had spent much time on mathematical investigation on conventional propeller aerodynamics, but results were not in assimilable form for practical designers with unspecialized mathematical ability. A new exposition of S. Drzwiecki's 'blade element' theory evolved by M. A. S. Riach now placed it on a practical basis which enabled direct application of wind-tunnel results to be used in comparing trial designs.

A new recruit joined the British aircraft industry that summer. He was an unknown Flemish soldier, Marcel Lobelle, aged 24. Wounds had brought him to a hospital among the fragrant heaths and pine woods not far from Brooklands, and while convalescing he used to make pen sketches of the surrounding countryside or the war-time scenes that haunted him. A friend introduced him to Fred Raynham, on whom Martinsydes had first call as a free-lance test pilot. Discovering Lobelle could draw, he recommended him to George Handasyde for employment as a draughtsman, resulting in a job that August at the unremarkable salary of £2 a week. The drawing office occupied a cottage near the racing track. 'Handasyde was a little man, with bright sharp eyes, and small fierce moustache. His chief draughtsman, Stanbury, told me to make a tracing of a drawing. I had never seen a piece of tracing cloth in my life, and used the wrong surface which quickly smudged. I showed it to a draughtsman called Kennedy who spoke French, and he quickly put me right. At that time Handasyde was redesigning the F.3 single-seater fighter,' Lobelle told me, recollecting those war-time days, and added: 'I had the greatest admiration for Handasyde, and though insulting and rude he was a brilliant man. We had great difficulty in talking because I only knew a few words of English, but he was good to me because he saw that I could draw and might eventually make a useful draughtsman. There were ten or twelve of us in that cottage, using a room about the size of a modern lounge.

'I used to go on the aerodrome at lunch time to watch the aeroplanes fly. The Sopwith works were at the west end, and the Martinsyde sheds were in the middle. I remember one day seeing a Spad parked on the field. It was breathtaking. It was marvellous! When I went up to it Harry Hawker brusquely told me to clear off. He wore funny trousers and I thought him a *poseur*. He got into a Dolphin, and a pilot in leather coat, whom I later discovered was the famous French fighter, Charles Nungesser, climbed into the Spad. They started the engines and took off. Soon there was a tremendous mock fight in the sky above Brooklands. Everyone was watching. It was marvellous – but Nungesser won.'

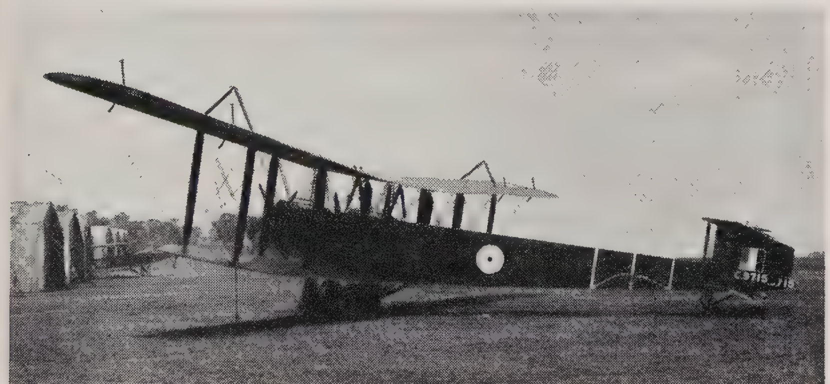
The Martinsyde F.3 was a single-bay biplane displaying George Handasyde's supreme artistry for line and composition, though clearly based on Fletcher's single-seaters of the previous year. In general appearance it was an enlarged but more attractive-looking S.E.5, designed for an experimentally uprated 285 hp Rolls-Royce Falcon despite the enormous demand for the generic engine to power the Bristol F.2B Fighter, which was now the popular favourite after initial teething troubles in squadron use, coupled with faulty tactics through flying the machine merely as a platform for the observer's gun instead of relying on the pilot's gun as the primary weapon and the observer's gun only for defence.

Tested in November at Martlesham the Martinsyde proved easily the fastest fighter so far made, for it was 10 mph swifter than the Dolphin, and

The Martinsyde F.3 prototype, at Martlesham, had an experimental 285 hp Rolls-Royce and was a refinement of the dimensionally similar Martinsyde R.G. Despite spectacular performance only a few were built owing to restricted availability of Falcon engines. (*A. R. Boeree.*)

could beat the production model to 15,000 ft by the handsome margin of seven minutes. As the most brilliant performer and highest climber of its day, it was officially described as 'a great advance on all existing fighting scouts'. But there was now this great drawback of Falcon unavailability, nor could this engine's current production be increased as all additional floor space was devoted to the more powerful Eagle required for the new O/400 version of the now well-proved O/100 Handley Page twin-engined bomber. Preliminary consideration was therefore given to fitting a 300 hp Hispano.

By early autumn it was clear that Rolls-Royce would not even be able to produce sufficient engines for the Bristol Fighter, and Barnwell was re-designing its nose to take the 200 hp Sunbeam Arab, for production of the equivalent Hispano was also at breaking point due to faults in early



The temporary canvas hangars at Cricklewood were big enough to take a folded Handley Page O/400. Some of the C9700 series (illustrated) had 350 hp Liberty engines in 1918. (*S. T. A. Richards.*)

engines. The first 150 of the production F.2B series had been fitted with the 190 hp Falcon I, but the engine was uprated to 220 hp and known as the Falcon II for the next 50 machines. When Rolls-Royce overcame current production difficulties it was intended to fit the fully developed 275 hp Falcon III.

The bulky nose with high top coaming and cowling had been criticized by squadron pilots because the forward view was obscured when climbing to attack. Barnwell made a drastic modification by breaking the line of the top longeron between the two cockpits and sloping it steeply down, then fairing the coaming with flatter tumble-home to give better diagonal forward view. For greater efficiency, the open lower centre-section of the F.2A was replaced by a normal aerofoil surface for the F.2B, and the tailplane was made with greater span and reduced chord to increase elevator power when landing, though there had always been ability to trim tailplane incidence with a cockpit lever connected by cables passing aft to upper and lower bell-cranks having arms carrying a floating bearer into which the root ends of the tubular front tailplane spar were inserted.

Years later I flew the final version of the Bristol Fighter as my first Service type. Compared with the Bristol P.T.M. on which I had learned, the wings seemed enormous from the cockpit, and massively boxed by struts and wires. Though the centre-section hardly impeded the vista above and ahead, one could understand the recurring war-time criticism that the lower wings of machines like the D.H.9 and the Bristol Fighter obstructed immediate downward view for reconnaissance; though the D.H.9 was worse because the pilot was farther behind the wing, whereas in the Fighter he saw steeply over its leading edge, and the R.E.8 was better still. We had no parachutes; cushions were piled high on the upright basket seat to give enough forward view. Beneath the seat rested the rear fuel tank, and a forward gravity tank was under the fairing in front of the pilot. The instrument board was simple, with ASI, altimeter, side-slip bubble, revolution indicator, oil pressure gauge; on the centre-section rear spar was a small eye-level compass with degree scale fixed peripherally on the needles. A wind-driven pump maintained 3 lb/sq in pressure in the main tank, but if it failed there was a stand-by hand pump mounted slantingly in the cockpit. To a novice pilot the petrol system seemed intimidating as there were six cocks controlling air pressure, and the instruction book baldly stated: 'If either tank is allowed to empty during flight, the air pressure is released, the air passing to the carburettors, thus starving the engine and causing serious risk of carburettor fire.' The pressure gauge was therefore the object of constant attention.

Having checked that wheel chocks were in place and mechanics either side were holding down the tail, the simple cockpit drill was to ensure switches off, set the trimmer, waggle controls for freedom, crane downward at the fuel gauge on the top of the rear tank, turn on appropriate fuel cocks, and pump up pressure. The big propeller was pulled round by a couple of men while the pilot primed the engine with a small 'Ki-gas' pump. Half a

dozen turns and they were waved clear. Swinging the prop was *de trop*, for the engine featured a hand-starter magneto which was spun vigorously with main switches on. There would be a convulsive kick and a grating rumble, then a continuing and distinctive chatter from the gear-box as the propeller whirled into an easy tick-over.

A few minutes warming and a run at full throttle while the mechanics sprawled over the tailplane with overalls streaming in the slipstream, then chocks and crew were waved away, and the Fighter, rolling slightly, taxied out, turning cumbrously at bursts of greater power for added slipstream on the vigorously angled rudder. Taxi-ing up-wind was easy, but unless there was a mere breeze, down-wind was another matter with a man at each wing-tip to prevent swinging wildly, though skilled pilots could manage at slow speed, using sharper, shorter bursts of engine.

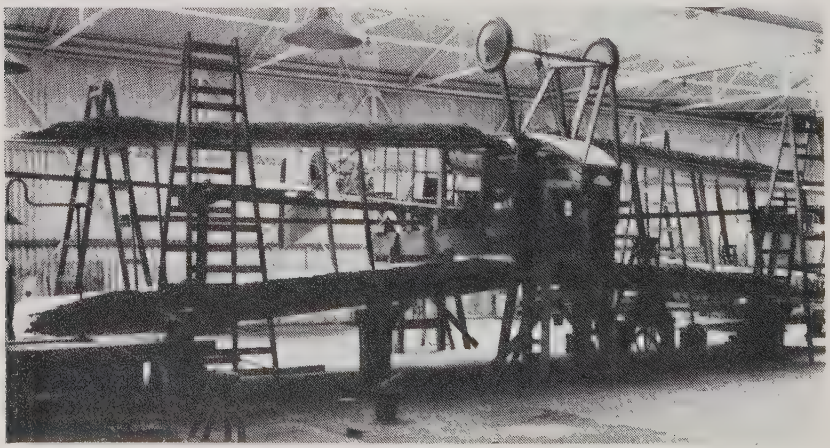
Built by its design company, this Bristol Fighter F.2B had a Falcon III engine, but was rare in having a four-blade propeller. In its standard fighter–reconnaissance form the Fighter won undying fame, for it was easy to fly, manoeuvrable and strong. (*Courtesy C. H. Barnes*.)

Turning into wind, one stopped, surveyed the sky behind and the ground ahead to make sure no aeroplane was near, then opened up. With stick well forward to lift the tail, the Fighter ran like a magnificent eagle, sailing into the air in stately fashion at merest hint of backward stick from the pilot. We might gasp for breath in the thundering gale of slipstream, but she flew with steady precision, stability adequate, response to controls easy and confident; though as speed increased the ailerons became rapidly heavier and on attaining 150 mph in a dive it took considerable strength to move the stick sideways, giving false impression of slow response. It was not aided by the exposed and flailing control cable between fuselage and outer wing-bay. Nevertheless the Fighter called for aerobatics. By trial and error I learned how to loop and roll and spin, and the machine always responded with easy confident steadiness. In those days it was

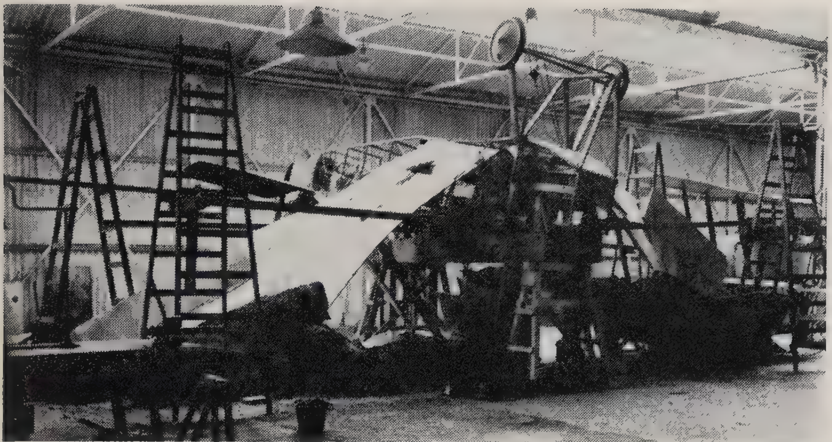
regarded as a breach of faith to 'rumble' the engine during an approach, for the glide gave a comfortable and commanding angle, and with a little excess speed near the ground the machine would steadily float while the tail was gently lowered to hold off, resulting in remarkably consistent three-point feather-light landings, despite the undamped shock absorbers. Yes, we loved the Bristol.

The Experimental Flight of the Royal Aircraft Factory was endeavouring to put handling assessments of aeroplanes on more scientific basis. Roderic Hill, described by one writer as 'the soldier-poet of old', was now in command of flying, and proved an ideal interpreter for the scientific staff. 'It is difficult to express "manoeuvrability" and "stability" qualitatively,' he wrote, 'or to define the inter-reaction of the personal factor with control. Of what certain aeroplanes feel like there is prevailing conception; when the qualities which underlie the conception come to be analysed and the multitude of obscurities found, the attempt to investigate, define and classify them is involving years of research.' Maintaining like Tizard that a test pilot's temperament need not be scientific but rather should veer towards the artistic, he nevertheless had a clinical approach towards observation of flight phenomena. His group of pilots agreed that the Bristol Fighter had pleasant lateral control, but they found the machine difficult to roll with the original small rudder. One reason suggested for the pleasantness of the Fighter was that it differed from machines like the R.E.8 in having a more comfortably disposed cockpit, with the hinged bottom of the control stick farther forward and the pilot's legs unrestricted sideways, thus giving greater lateral freedom of stick movement and consequently greater maximum control.

There was particular concern with behaviour in dives, not only of the



Despite the increasing accuracy of strength calculations it was desirable to substantiate them with full load tests to destruction. Here an Armstrong Whitworth F.K.8, somewhat crudely loaded with sand, is evaluated at Farnborough. (*Royal Aircraft Establishment.*)



The Armstrong Whitworth F.K.8 after completion of full load tests to destruction. (*Royal Aircraft Establishment.*)

Fighter but all other operational aircraft, for this so often proved the avenue of escape from German fighters. It was found that the S.E.5 could attain 250 mph in the first 1,500 ft drop with engine on, and the terminal velocity was 265 mph at an angle they had believed vertical, but was nearer 45 to 60 degrees. The margin of strength was considered high, despite several occasions when wings had broken off although modified following Goodden's crash. Farnborough technicians calculated that in a vertical dive about half the weight was supported by the wing structure as drag, but the wings were also under torsion through a moment due to air forces even though the resultant of lift at right angles to the wind was zero. This put a down-load on the front spar and an equal up-load on the rear spar equal to 2·3 times the weight, but the factor of safety under the combined drag and twist was still 2 on the front spar and 3 on the rear, and stresses on the rest of the aeroplane were inconsiderable.

'One of the chief objections to diving at very high speeds is that intense vibration is often set up,' stated R & M No. 494 of 1917. 'This naturally gives the pilot cause to think that the machine is intrinsically weak, and in any case continuous vibration is very bad for any structure. Much of this vibration is undoubtedly due to high engine speed. Probably a great deal more is due to the wires, which are also responsible for much of the noise. But it is important to see if any is due to what appears as the rapid change of centre of pressure near no lift. Although the position does change very rapidly the *moment* on the wings changes quite slowly, in fact more slowly than at ordinary speeds, and it appears probable that very little of the vibration is due to this cause.'

To obtain further information on manoeuvre loads F. C. Searle, with F. A. Lindemann piloting, conducted much flight research with an early form of accelerometer, film recording the tip movement of a semicircular

fine glass fibre while a B.E.2c was being heavily manoeuvred. Using typical control hand loads they found a loop at 95 mph imposed 3·2g; rolling gave 2·8g; sudden stall at 85 mph produced 2·8g; and ordinary bumps were anything up to 1·5g, though negative g was not recorded. To substantiate these tests another fighter pilot, Capt 'Oogy' Noakes, that past-master of violent side-slips in forced landings, performed a mock dog-fight with Roderic Hill using an S.E.5a against his R.E.8: up to 4g was recorded. Nevertheless, Farnborough scientists were still unaware that sharp-edge gusts could produce abrupt changes of load due to instantaneous change of wing incidence and associated lift, and this could be superimposed on manoeuvring loads with disastrous results.

The combined mathematicians of the Air Board, following the merger of Admiralty and War Office technical responsibilty, were deeply engrossed with problems of strength. A. J. Sutton Pippard was now in charge, with J. Laurence Pritchard as second-in-command. The volume of work grew apace and they were in a constant state of staff shortage. This led to heavy incursion of the feminine into the section. Several brilliant young women from Cambridge, among whom were Hilda Hudson and Letitia Chitty, had quickly assimilated the engineering requirements of mathematics under the guidance of Pritchard and were engaged on stressing and check stressing every new design. In his RAeS Centenary contribu-

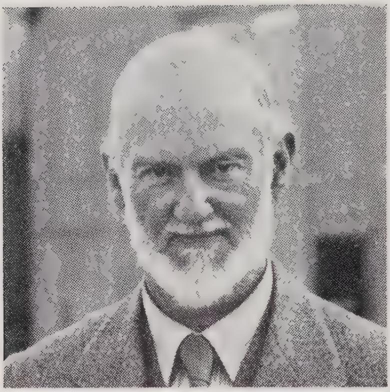
The merged Air Department 1918. In the centre is Major Ogilvie with J. A. Sutton Pippard seated to his right and Miss Hudson, left. In the middle row, Miss Chitty second from the left, and the two men are Capt T. M. Wilson who stressed the Handley Page and Capt J. Laurence Pritchard behind whom on his right is John Case and left H. B. Howard. (*Courtesy The Royal Aeronautical Society.*)

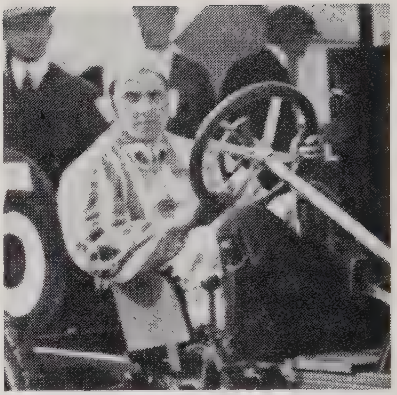
tion Sutton Pippard recorded that: 'Before I joined the Department, Harris Booth and Harold Bolas had provided a complete mathematical solution of the continuous beam over a number of supports with different axial thrust loads in the several bays. This had been circulated as a confidential document for the information of Admiralty contractors, and had been used in the design of the A.D. seaplane. The solution involved a number of trigonometrical and hyperbolic terms, and by the standards of 1915 its application was arduous. A copy of the document fell into the hands of Arthur Berry, a senior wrangler and Vice-Provost of King's College Cambridge. He became interested, and recast the solution into a much more elegant mathematical form, and in particular grouped the awkward terms into a number of functions whose arithmetical values he had calculated and tabulated over the full range required. This made the method far easier to use, and it became ultimately associated with Berry's name – the functions always being spoken of as "Berry Functions". Altogether it was a notable piece of work by an exceptional professional mathematician, but resulted in overshadowing the fact that the original solution, known in the Department as $(HB)^2$ from the initials of both authors, was the work of Booth and Bolas who I think have received insufficient credit for an important contribution for the Theory of Structures.'

In many ways the science of structures had become more advanced than full understanding of aerodynamics, for despite the lead Lanchester had given to this country with his vortex theory and postulation of induced drag, the resistance of three-dimensional wings was still being treated empirically, based on charts of experimental data showing the effect of aspect ratio on the drag of biplanes. Luckily it was only of secondary consequence, for the more obvious solution leading to increase of performance depended on the engine designer's ability to boost power again and again.

3

Slowly the Achilles' heel of engine production was recovering, and new designs were beginning to prove second to none. Rolls-Royce was paramount. The company's activities were brilliantly managed by Claude Johnson, with Arthur Wormald as works manager. It was at least due to Farnborough's preliminary design that Henry Royce had commenced work on his first twelve-cylinder vee water-cooled engine, the prototype Eagle, which had been followed by the smaller and lighter twelve-cylinder Falcon with intention of concurrently supplying both bombers and fighters with suitable powerplants. From 200 hp in March 1915, the Eagle's power was steadily stepped up, and it was envisaged that by the end of the year the latest version would develop 360 hp. Working from his private house at St Margaret's Bay, where A. G. Elliott and Maurice Olley were his chief assistants, Royce, a tall and erect, scholarly looking man with thinning hair and small white beard, originated and supervised every aspect of design, entrusting the manufacturing problems to his trusted





Frederick Henry Royce (left), the master architect of superb engines who inspired perfection of Rolls-Royce design and the consequent success of many British aircraft, and Alfred Hubert Roy Fedden in his racing Straker Squire car of his own design. He was commissioned in the RNVR on the outbreak of war, but was transferred back to engine production.

mechanic Ernest Hives, who was in charge of the experimental shop. Soon J. E. Ellor, Farnborough's specialist on superchargers, joined the team.

The Bentley rotaries were in a class of their own, but Rolls-Royce had a major aircraft engine rival in D. Napier & Sons Ltd, who had been impelled by the Government in August 1915 to work on the twelve-cylinder water-cooled RAF 3a, and in the following year received a large production order for the still unproved Sunbeam Arab. Meanwhile Montague Napier, the tall, black-bearded, deliberate but retiring grandson of the founder, argued that his company should produce its own design, and convinced his directors by offering to finance the project himself. In the capable hands of bespectacled A. J. Rowledge, their quiet methodical chief designer who at 41 was older and more experienced than his contemporaries, a broad-arrow twelve-cylinder of Hispano-like cleanness was designed, estimated to produce 450 hp – the most powerful engine in the world.

Next in importance of new aero-engine companies was the Siddeley-Deasy Motor Car Co where Major Green was supervising both development of Heron's fourteen-cylinder RAF 8 engine and the aircraft design of J. Lloyd. But the Puma development of the BHP was controlled directly by John Siddeley who was employing for this purpose F. R. Smith, chief designer of his cars, described as 'a wonderful personality' – and he needed to be to cope with the difficult but clever Siddeley.

Recently the Air Board had invited tenders for an air-cooled engine of 300 hp, weighing not more than 2 lb/hp, which they considered essential for the next generation of fighters. Four firms submitted designs – Brazil Straker, Siddeley-Deasy, Vickers and A.B.C. Motors. The dark-haired, rather sombre Fedden of Brazil Straker was a natural designer like Royce, rather than a theoretician, and was determined to enter the field with a remarkable static radial with fourteen cylinders disposed along a two-turn

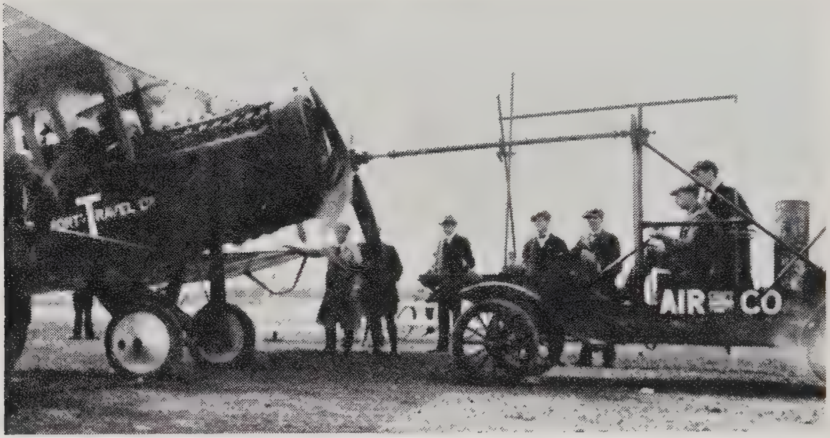
helix, using two crankpins with seven side-by-side big-end roller bearings– a design possibly indebted to the unsuccessful ten-cylinder single-row radial engine which the American, John W. Smith, had got the British Government to nominate for Vickers and Port Victoria aircraft before it was properly developed.

Fedden now won the Air Board's contract for 200 of his design, which he named Mercury, and a similar order was reserved for Heron's RAF 8 now named the Jaguar – but at this stage Granville Bradshaw of A.B.C. Motors effectively argued with Sir William Weir that because he had proved 170 hp was developed by his new seven-cylinder radial Wasp for a weight of only 290 lb he could promise not 300 hp, but 340 hp from a nine-cylinder single-row radial and keep within the 600 lb weight qualification. Rashly decision was taken to standardize this engine, the Dragonfly, though it had not even been built, leaving the Mercury and Jaguar as second string. On official promise of this A.B.C.'s early availability, the majority of aircraft designing teams began provisional work on a wide range of fighters, reconnaissance machines and bombers to be powered by it, for the light weight would give brilliant performance.

That summer Capt B. C. Hucks, RFC, Airco's test pilot, and former associate of Robert Blackburn, lectured to the Aeronautical Society on *A Further Three Years Flying Experience* and said that sheer increase of horse-power was more responsible for present-day performance than any reduction of drag, though there had been marked improvement in handling due to inherent stability. 'I find that on stepping out of a very fast small scout into a really big twin-engine machine, the difference in piloting techniques is slight compared with the vast difference in the machines. Precisely the same methods are employed, the same trouble and risks are to be avoided; the chief characteristic seems to be that smaller and faster machines are more difficult to land but easier to handle in the air.'

After discussing flight techniques, spinning, accidents, and training methods, Hucks turned to blind flying and made the first public pronouncement that in a cloud: 'Of what use is air-speed indicator showing to the pilot 150 mph if the machine is on a spinning spiral, and he imagines that he is merely descending too fast on a steep, straight glide? He naturally tries to pull up, but with no effect. The bubble does not help as centrifugal force will send that anywhere. What I want to see fitted is an instrument which will show a constant vertical or horizontal line and be independent of centrifugal force. I have no suggestion as to how this is to be brought about other than something in the nature of a small gyroscope driven by an airscrew.' Here was shade of Sir Hiram Maxim and his effort twenty years earlier to incorporate gyroscopic control in his giant aeroplane. Only Lawrence Sperry in America was likely to provide an early answer.

A contemporary recalls how Benny Hucks stalled his engine on landing, and the machine stopped at the far end of Hendon aerodrome. 'Obliged to take a long walk back to the hangars, Hucks, who stammered when excited, sought out de Havilland to report. The outcome was that I received



The invaluable Hucks starter was to prove the only practicable starting method for big engines for many years until the advent of inertial and electrical starting methods.

instructions to get out a scheme for a non-manual starter, using a Model T Ford aerodrome truck to provide turning power. I finally decided that Huck's idea could be accomplished, using a vertical pillar fastened to the floor of the truck immediately above the gear-box from which a chain drove a sprocket at the top of the pillar and revolved a horizontal arm projecting beyond the car. A spring-loaded sliding extension, with two-pin plug on its end, compressed when pushed forward, and engaged a bayonet socket attached to the propeller hub. Once the truck engine started, the revolving arm began to turn the propeller until the revolutions were sufficient for the aircraft engine to pick up. The compressed spring then automatically released, and the revolving arm pulled itself clear'. Seven years later the Hucks starter was still the standard, and I made one for Westland, sawing a Ford T in half and lengthening it to accommodate an additional clutch and retain normal ground mobility.

Not only ingenious devices, but many new aeroplane designs were beginning to emerge from less well-known designers than the stalwarts of Airco, Sopwith, Bristol, Handley Page, and A. V. Roe.

R & M No. 348 revealed that tests were being conducted by A. Fage, ARCSc, at the NPL on a large bomber-fighter biplane designed by the Grahame-White company. Described as Gotha type, but with two long tractor bodies carrying a biplane tail and a middle pusher body, it had three 270 hp Sunbeam Maoris, and the loaded weight of this 89 ft span machine of 16,000 lb was more than 3,000 lb greater than the new Handley Page O/400. At this juncture Grahame-White announced that he was now sole managing director, as his co-director F. H. Paine, with whom J. D. North had such disastrous difference of opinion, was no longer a member of the company. Currently Grahame-White had N. Martineau as chief designer.

John North now left the Austin Motor Co having found that his position as an authoritarian had again become impossible. This gave opportunity for yet another Farnborough designer, John Kenworthy, BSc, accompanied by H. A. Webb, MA, a mathematician, to discover by joining the company whether the field of industrial design and manufacture was more rewarding than a government job. As a start he secured a private venture licence X15 to build the A.F.T.3, later known as the Osprey, a diminutive triplane of 23 ft span and only 17½ ft long, which had been draughted under North's jurisdiction by the same designer as the Austin Ball judging by strut fittings and tail. Simplicity of construction was the key-note, and its Camel-like fuselage was built with only two types of spacer and bracing clip. Similar standardization was made in the three wings, which were identical, despite their differing loadings, and had interchangeable interplane struts.

The Austin A.F.T.3 Osprey began its official trials at Martlesham Heath in March 1918, but was considered unsuitable because of blanketing of landing view. Non-linearity of interplane struts may imply rerigging for deficient stability, and the finless rudder must have imposed directional problems. (*A. R. Boeree.*)

At Armstrong Whitworth there had been similar change. Frederick Koolhoven left, following ill-success with his last three designs, the F.K.10 quadruplane with wing structure related to the Sopwith triplane, the 'Philips' fifteen-winged F.K.11, and the mono-triplane F.K.12. Accompanied by Bob Noorduyn he joined Samuel Waring's latest aircraft venture, the British Aerial Transport Co Ltd of Willesden. An immediate flow of widely ranging designs ensued, of which the first nine are unknown, leading to a very unconventional light-weight fighter, the F.K.22. Inspired by the monocoque fuselage which his mentor, Béchereau, had designed before the

The heavy stagger of the prototype Armstrong Whitworth F.K.10 enabled the pilot to be placed forward, with outstanding all-round view. A small batch with deeper fuselages was ordered by the RFC and RNAS. (*G. Quick.*)

war for the Deperdussin racer, Koolhoven drew a biplane which might have been its direct successor with wings attached to top and bottom of the deep elliptical-section fuselage, and the pilot sat, somewhat as in the Dolphin, with head protruding through a circular hole in the upper centre-section. The two-bay 25 ft span wings were made with detachable outer bays to a wide centre-section carrying the undercarriage Vs beneath, which incorporated vertical coil shock absorbers, and afforded abnormally wide track compared with other single-seaters. Unfortunately its six-cylinder 120 hp Mosquito engine at this crucial point failed to materialize.

The B.A.T. F.K.22 had a 100 hp Monosoupape substituted for its A.B.C. Mosquito without altering the original steeply upward sloped nose of the fuselage, and in this form, known as the Bantam Mk II, was tested at Martlesham Heath in February 1918. Later a 110 hp Le Rhône was substituted. (*Imperial War Museum.*)

As consequence of Koolhoven's move, Fred Murphy, late of Luke & Co, the yacht-builders at Hamble, and in pre-war days a trainee of Bristols, was appointed chief designer at Armstrong Whitworths. Probably his initial designs there were derivatives of those initiated by Noorduyn and Koolhoven, for his officially sponsored F.M.4, named the Armadillo, had remarkable similarity to Koolhoven's new B.A.T., though the ply-covered fuselage of Murphy's machine was flat even on top, with sides recessed at the cockpit to give better view.

The private venture Armstrong Whitworth F.M.4 Armadillo bore the impress of Koolhoven, but suffered the disability of bad landing view like so many other aircraft of the time having a wing set at eye level. (*G. Quick.*)

At William Beardmore & Co Ltd in Dunbartonshire, Lieut G. Tilghman Richards, RNVR, their Admiralty inspector of aircraft who in pre-war days designed a far-fetched circular-winged aeroplane, had been allowed to resign his commission early in 1916 and accept appointment as chief aeronautical designer. The firm originated in 1815, and was one of the oldest engineering concerns in Scotland, and in 1903 had added shipbuilding. With the acquisition in 1913 of Arrol-Johnston cars, 47-year-old Sir William Beardmore had decided that aero-engines had a future and for £10,000 obtained a licence to manufacture the Austro-Daimler, complementing this with aeroplanes in 1914 as licensee for the impressive German D.F.W. biplane which the company demonstrated that year. With war, orders for B.E.s followed. In January 1916 airship construction began, and after some months Tilghman Richards was appointed assistant aviation manager in addition to his designing duties. His first creation, a huge 61 ft 6 in span bomber, like the equivalent but still bigger Short, had been rendered obsolete by the Handley Page O/100. As Beardmores were building large numbers of the B.E.2c, Tilghman Richards next attempted to bring this design up to date by adopting the current configuration with gunner behind pilot, fairing the fuselage to circular section, and fitting a 200 hp

Just as Koolhoven had improved the B.E.2c with his F.K.3 redesign, so Tilghman Richards made a later attempt to achieve still better performance with his Beardmore W.B.II powered by a 200 hp Hispano-Suiza, but despite a good Martlesham report it did not merit production. (*G. Quick*.)

Hispano-Suiza, though the latter was a forlorn hope as every engine was required for S.E.5a and Dolphin production. More important was major conversion of the Sopwith Pup, analogous to Fairey's Hamble Baby version of the Sopwith Schneider. Officially designated S.B.3F, and ciphered W.B.III at Beardmore, it was unstaggered, with slightly less span, greater gap and a longer fuselage than the Pup to prevent fouling the tail when folded, and had full-length centre-section struts and incidence wires exterior to the fuselage in order to prevent the folded wings twisting. The 'F' version had unique ability of hand 'folding' the undercarriage within the fuselage, drawing the wheels aft and upward until only half the diameter projected so that the machine could be more easily handled and stored within the *Campania*'s hangar deck. The 'D' variant had a droppable

The Beardmore W.B.III (S.B.3D) was a rearrangement of the Sopwith Pup to replace the Sopwith Baby seaplanes carried by HMS *Campania*. The permanent centre-section struts exterior to the fuselage considerably increased drag so that the W.B.III's top speed with only 80 hp was 103 mph compared with the Pup's 111 mph. (*H. Busteed.*)

undercarriage for greater safety when forced to alight on the sea, and emergency flotation bags were carried in the fuselage and under the wings. Surprisingly neither of these novel undercarriages was patented so it may have originated among the Naval pilots at Grain, where the prototype W.B.III arrived during the week-end of 28 July and was tested by Busteed. In *Early Bird* Major W. Geoffrey Moore commented that though Pups were very controllable and pleasant to fly, those modified to fold by Beardmore had their performance and handiness rather spoiled, in part due to elimination of stagger, but mainly because the Beardmore W.B.III had only an 80 hp Le Rhône compared with the current 100 hp of the Monosoupape Pup.

The Beardmore W.B.IV to specification N.1(a) was designed by Tilghman Richards to give the pilot a unique fighting view by locating him in front of the wings and using shaft drive from the 200 hp Hispano-Suiza engine behind him. The W.B.IV was one of the most technically advanced aircraft of the war but its speed of 110 mph was somewhat disappointing. (*H. Busteed.*)

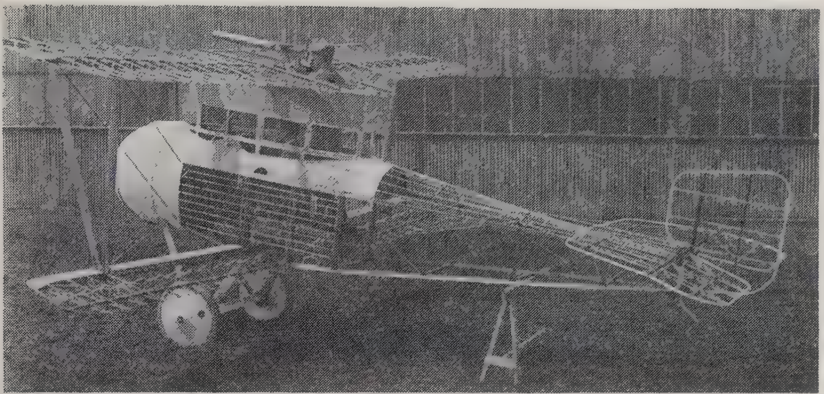
With such valuable practical experience of Naval requirements to his credit, Tilghman Richards was now designing the W.B.IV, a strikingly original two-bay single-seat biplane in which the pilot sat in front of the wings right in the nose, with a tremendous view, and the engine, a 200 hp Hispano, was mounted behind him within the fuselage, driving a tractor propeller through a torque shaft passing under his feet. It was the world's first application of shaft drive to tractor design, though there had been

several tail-pushers. The nose of the watertight, ply-covered fuselage formed a large buoyancy chamber of which the lower part was heavily chined outward to give a forward planing surface so that the machine could more safely alight on the sea after jettisoning its undercarriage. Concurrently another single-seater, the W.B.V, was being constructed with a chineless basic fuselage structure, utilizing unstaggered top and bottom wings of the same span and chord as the top wing of the W.B.IV, and the same tail units. It was intended to carry a 37-mm cannon firing through the geared hollow propeller shaft.

Built to the same specification as the Beardmore W.B.IV, the Mann Egerton Type H.1, designed by J. W. Carr, was somewhat influenced by the SPAD G in production by that firm, but was a simpler attempt at the N.1(a) specification using an external tank-like buoyancy chamber and droppable undercarriage. (*H. Busteed.*)

Mann, Egerton & Co Ltd of Norwich were also in the running for Naval requirements, competing against the Beardmore W.B.IV with a two-bay single-seat shipboard fighter designated Type H, designed by J. W. Carr and similarly powered by the universally demanded 200 hp Hispano-Suiza. More conventional than the Beardmore it had a large detachable buoyancy chamber in the form of an ugly wide-chord float attached to the bottom of the fuselage, and was jettisonable like the undercarriage.

At Peterborough, Gordon England, after his first attempt with the Sage Type 1 twin-engined bomber, had diverted design work to the ex-Bristolian, Clifford Tinson, who had left the Admiralty Air Department to join him in January 1916. Their first effort was the Sage Type 2 biplane indicative of marriage between the V-strutted Nieuport and the Barnwell–Tinson-designed Bristol Baby; but its remarkable feature was a streamlined, multi-windowed fairing filling the gap between cockpits and centre-section so that the gunner could stand in the rear position shielded from air blast but with his head through a hole in the centre-section where there was a



The Sage Type 2, designed by Clifford Tinson as a two-seat fighter giving a protected gunner the forward field of fire denied by absence of interrupter gear, had a speed of 112 mph which was quite good for a two-seater with a doubtful 100 hp. Apart from the cabin enclosure, the structure was typical of contemporary aeroplanes. (*Courtesy C. H. Barnes.*)

top-mounted Lewis gun. Flown on 10 August, 1916, it was even then obsolete because Sopwith 1½-Strutters with Scarff-Dibovski synchronizing gear were already operational. The Sage team was then given a contract for a slow landing primary trainer of more robust construction than the Avro 504, resulting in the Sage Type 3, a much more handsome machine than de Havilland's D.H.6 – but when flown early in 1917 general handling had not got the requisite qualities of a trainer, nor was there sufficient know-how of test flying and aerodynamic modification to make it satisfactory. As the machine was not fast enough for other use, the original large order was

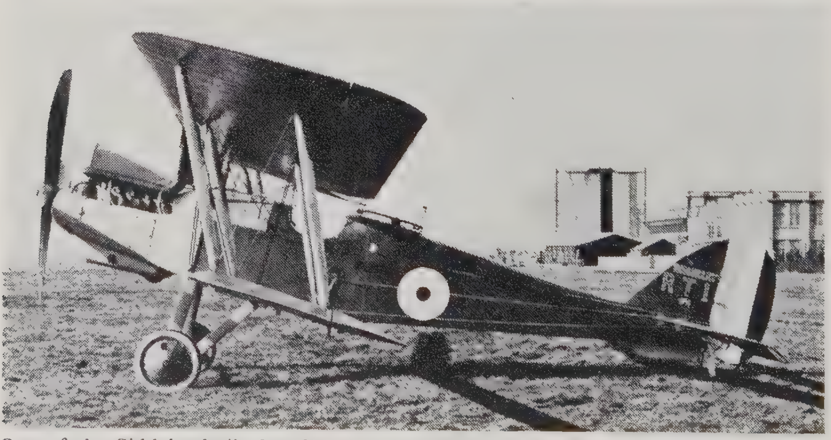
The Sage Type 2 after covering. The neatly cowled engine was a Gnome Monosoupape. (*Courtesy C. H. Barnes.*)

cancelled, and Gordon England used it as a runabout, but it led to design of a single-engined patrol seaplane to specification N.2(a) issued in April 1917.

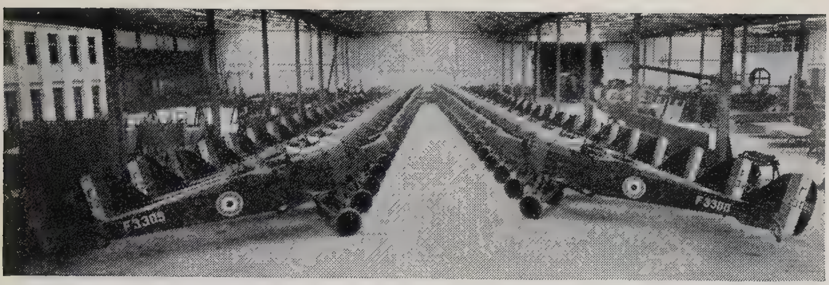
Sage No. 4 was quickly produced from an adaptation of Type 3, with the same span, overall length, chord and gap, and fitted with conventional pontoon floats. Satisfactorily flight-tested on 3 July, it was now perversely recommended as having handling qualities suitable for a seaplane trainer but not as an operational machine. Redesign for the new use resulted in upgrading power from the 150 hp Hispano to 200 hp in the dual-control version Type 4b, but conversion was on low priority as the Admiralty soon insisted that the final form must have wing folding incorporated, and this meant yet another redesign as Type 4c.

At Siddeley-Deasy, J. Lloyd and Major Green had completed design of their version of the R.E.9, and the experimental shop was well ahead with construction through taking a production R.E.8 fuselage, No. B6625, as basis, modified with an S.E.5-type nose and a 200 hp Hispano. The decking was raised a little to give the gunner a higher firing position over top wing and tail, but the greatest apparent departure from the R.E.9 was that the latter had equal-chord two-bay wings reminiscent of a B.E.2c compared with the wide-chord top wing and narrower lower wing of the R.T.1 in the new fashion recommended as aerodynamically beneficial by the NPL wind-tunnel.

Siddeley-Deasy were now invited to tender in competition with Bristol, Sopwith, Airco, A. V. Roe, and Vickers, for design of a single-seat fighter to specification A.1(a), calling for a speed not less than 123 mph at 15,000 ft; climb from 10,000 ft to 20,000 ft in not more than 10 min; ceiling not less than 25,000 ft; ability to dive 'practically vertical without exceeding 200 mph'; very handy to control, and landing speed not more than 50 mph.



One of the Siddeley-built R.E.8s was converted by the builders to a two-bay variant with increased chord to the top wing. The first prototype R.T.1 had an S.E.5-type nose with 200 hp Hispano-Suiza engine, the second seen here at Farnborough, had a 150 hp RAF 4a, and a later machine had a 200 hp Hispano-Suiza with rounded nose, underslung radiator, and horn-balanced ailerons.

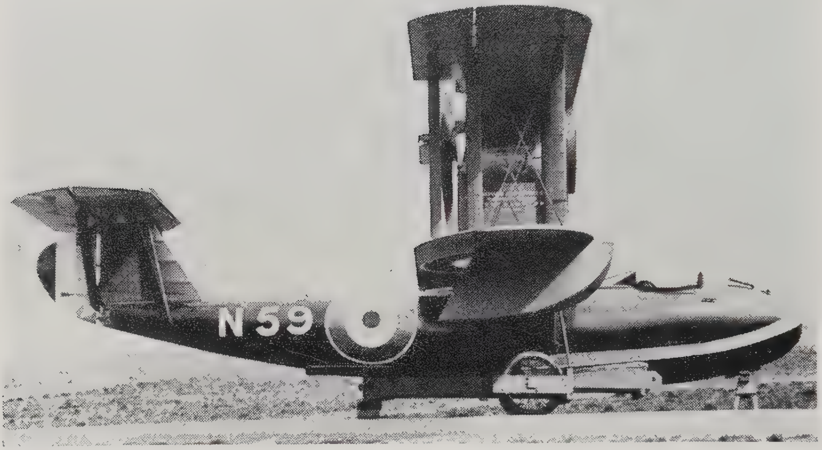


The last of the R.E.8s built at Siddeley-Deasy was the batch F3246–F3345. No other war-time design of aeroplane was built in such great quantities in Britain. At the right of the picture can be discerned the tail and components of a D.H.10. (*Courtesy The Royal Aeronautical Society.*)

Excellence of view was regarded 'almost as important as performance and handiness', and an air-cooled engine was preferred. It was specified that: 'Attention is to be paid to designing the fuselage so that the pilot is kept warm. The planes are to be rigidly constructed, and especially the leading edge up to the front spars to be stiff and strong. Strength factor not less than 8 on the front truss and 6 on the rear.' To that end Lloyd and Green were developing a design they had initiated at Farnborough – the S.E.6 fitted with the Jaguar radial. But Heron was at loggerheads with the forceful John Siddeley over construction of the cylinders which had been designed with aluminium heads and two valves inclined at a large angle to each other. Siddeley ordered them to be made with three valves similar to the Puma. Heron resigned – and presently this brilliant designer left England and accepted an engine development post with our new Allies, the Americans, developing cylinders and sodium-filled valves for a radial engine sponsored by the new Curtiss-Wright company.

Among several carefully considered specifications for envisaged operational aircraft required in 1918 and 1919 was a single-seat seaplane or flying-boat fighter, N.1(b), with a speed not less than 95 knots at 10,000 ft and a ceiling of at least 20,000 ft. Supermarine, Blackburn and the Norman Thompson firm decided to tender with flying-boats powered either by the 200 hp Hispano or the equivalent Sunbeam Arab. The Supermarine N.1B was the smallest, with a span of 30 ft 5½ in, compared with 34 ft 10 in for the Blackburn and 34 ft 3 in for the Norman Thompson, though the latter had noticeably greater area and two-bay wings instead of the single bay of the other two designs.

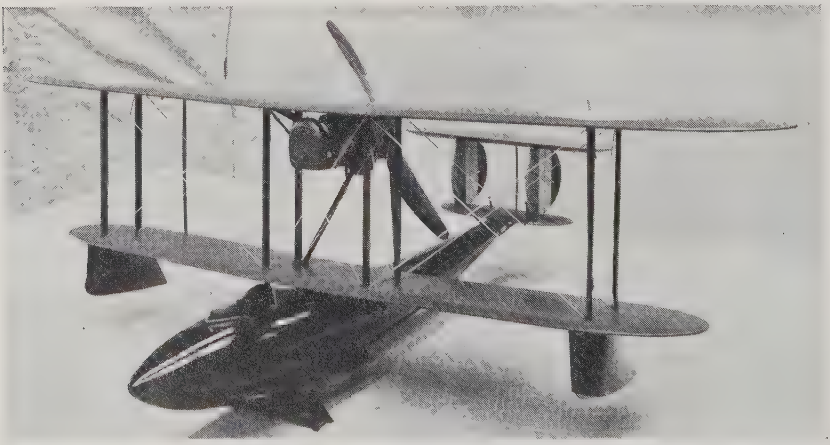
From Blackburns came a spate of patent applications, for the greater part in Harris Booth's name. Linton Hope independently obtained a patent for his special hull construction of closely spaced longitudinal stringers, wide-spaced main transverse bent-wood hoops, and multitude of close-set narrow bent wood ribs between. Both Blackburn and Supermarine adopted this form of hull, but F. P. H. Beadle at Norman Thompson was basing his on previous flatter-sided hulls of their N. T. series derived



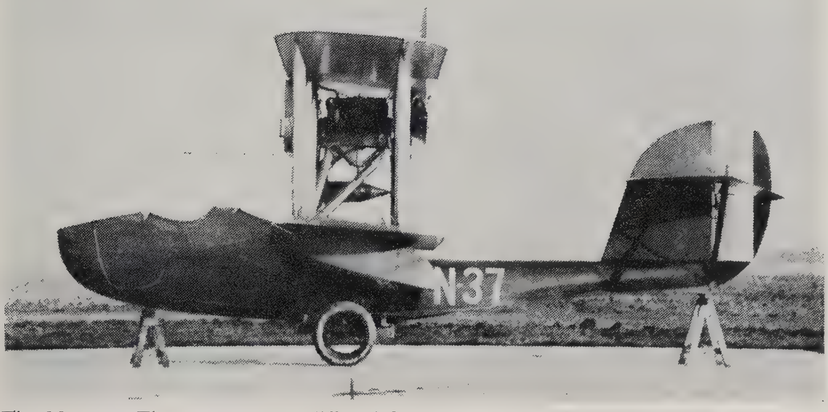
With Linton Hope hull, the Supermarine N.1B Baby was attractive and efficient, though the rudder was abnormally small. After first flights in February 1918 ailerons were added to the lower wings. Speed was 117 mph with a 200 hp Hispano-Suiza engine. (*Imperial War Museum.*)

from his monocoque Consuta-planked fuselage of the 1915 'Bognor Bloater' naval landplane.

As possible replacement for the Sopwith Baby, Port Victoria were designing and building a single-seat fighting seaplane of the same general type as P.V.2. This was P.V.9, but prejudice against high-lift wings was at its height, and the design staff were instructed to use RAF 15 section despite their protests at resultant high landing speed and loss of climb. Wing bracing was similar to P.V.2 except that the lower wing was supported



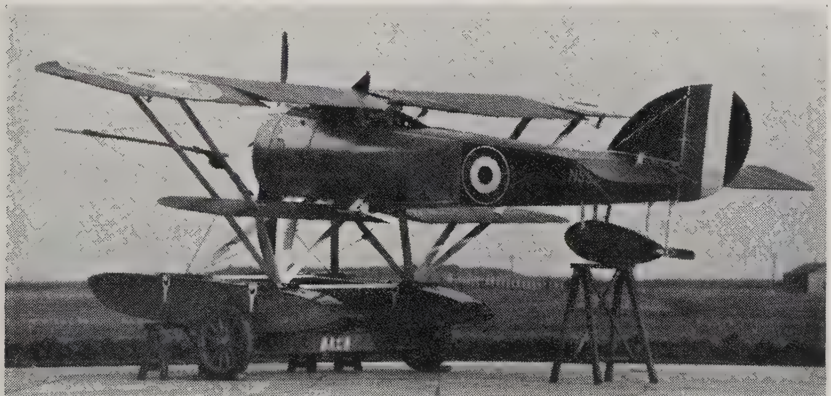
A model is illustrated of the Blackburn N.1B, known as 'Nib', but although the Linton Hope type hull was built the machine was not completed during the war. Thrust-line was rather high, but rudder power appeared adequate.



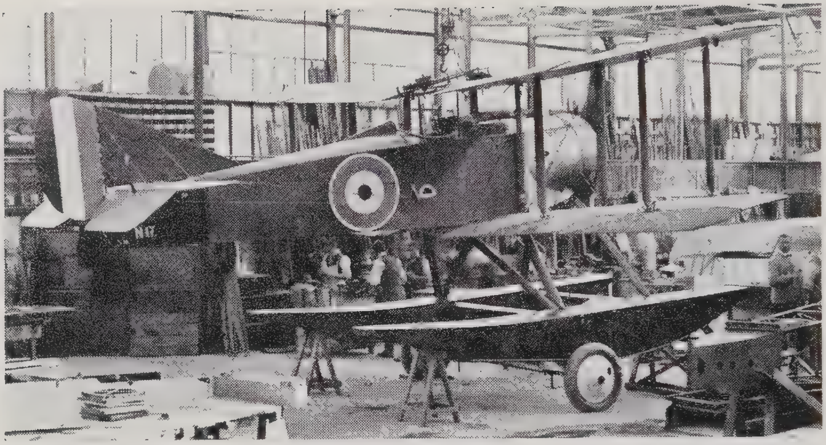
The Norman Thompson N.1B differed from other small flying-boats in being a two-seater, though all-up weight was only 300 lb greater than the Supermarine. First flights in September 1917 were promising, but official trials showed disappointing performance. (*Imperial War Museum.*)

by struts from the chassis to both front and rear spar instead of by one strut only. A synchronized Vickers gun and a Lewis firing over the upper wing were fitted, and a B.R.1 engine installed when one was at last available, for only 159 were completed during the year and demand was great. Initially tested in December, continuing engine trouble prevented proper trials until the middle of 1918, when the P.V.9 was reported as the best seaplane scout so far produced, but it fulfilled no Service need. Some time later the German Brandenburg monoplane began taking toll of the Curtiss flying-boats, and fighting seaplanes were ordered in panic.

At Yeovil Robert Bruce and Arthur Davenport had been designing a scout seaplane intended for similar purpose. The result was the twin-float



Port Victoria's P.V.9 single-seat fighter seaplane was based on the P.V.2 bis but with RAF 15 wings instead of the original high-lift section. Trouble with its B.R. engine delayed trials, but in 1918 the machine was assessed the best fighter of its kind. (*H. Busteed.*)



The second Westland N.1B Scout seaplane is shown in the converted oil engine shop of Petters Ltd at Westland Works. Long main floats rendering a tail-float unnecessary distinguished it from the prototype.

N.1B to the same specification as the small flying-boats but, like the P.V.9, using a 150 hp B.R.1. Much influenced in appearance and detail by Sopwith techniques, with which Bruce had become so familiar while Inspector there, it was given relatively large two-bay wings of a little over 31 ft span and 278 sq ft area to ensure adequate lifting ability for the requisite two 65-lb bombs with which the much smaller Baby had been overloaded. Two prototypes were being built in the Petter workshops, of which N.16 had conventional Sopwith-type pontoon floats and tail float, but N.17 introduced the novelty of floats nearly twice as long which gave sufficient aft buoyancy to dispense with a tail float. Like the Fairey Hamble Baby, the Westland incorporated a somewhat similar system of patented camber-changing trailing-edge flaps which Bruce devised.

Even before N.16 had been tested, his drawing office, like those of Fritz Koolhoven and Herbert Smith, was tackling an ultra-light fighter to be powered with the 170 hp A.B.C. Wasp – but the Sopwith team was simultaneously engaged on even more important projects to meet Air Board requirements for single- and two-seat aircraft.

5

At the mid-summer meeting of the Aeronautical Society Lieut-Col Mervyn O'Gorman, CB, gave the Fifth Wilbur Wright Memorial lecture, taking a hard look at the aircraft industry and its commercial future: 'For nearly three years aeronautical engineers have been working under intense pressure on a multiplicity of details of design and production. Many have thereby been forced away from their normal wide outlook and habit of detached thinking. Our minds have been moving forward as strap-hangers are moved forward by a train, amidst an intolerable crowd of immediate calls, while the general survey of the horizon – the trend of the past, the

prospect of the future – has been obscured by the crowd. Every estimate, tender, specification, every design, preliminary experiment, tool, and jig equipment for output is an expression of effort to foresee the position some six or twelve months ahead.'

He then went to the crux of the big associated problem. 'The bug-bear of any production is the uneven distribution in time of the orders received. The intolerable burden of keeping a staff and a system to give a large rate of output for a short time and at short notice should be put to an end by foresight. The Government will necessarily have certain orders of its own to distribute, which should be given at such dates and in such a way as to even the load curve of demand. The labour question is equally involved for the same reasons. The process of working "ca' canny" with a view to keeping his job or making jobs for others is by far the worst economic mistake of the labouring class. The labourer's desire for his share of wealth is no doubt accompanied by knowledge that it must be produced to be distributed, but this is overshadowed by conviction that the firm may fail to get more orders, that a lull may come – so he extends the period of activity between the lulls and secures jobs for his friends by working dead slow. Abolish the lulls, and the thin excuse for slacking vanishes.'

These crucial matters were the recurrent business problems of demand and supply affecting the entire productive economy. Judging by British temperament it seemed they always would be. But management had many minor but no less worrying matters arising from human relationships both in and outside a company. Earlier that year a Mrs Williams had written to Capt Wood of Vickers:

> 'One of the managers of your factories is a German named Muller, who lives with his German wife at Weybridge. He is detested by your workmen, whom he bullies. It is shameful our Englishmen, whose sons and brothers are fighting for us, should be insulted by having a German over them, who is a danger in works employed by the Government. I do not know if he is naturalized. Naturalized Germans are traitors to their own country, and must be got rid of.'

Mr Percy Maxwell Muller, the industrious 37-year-old works manager of Vickers Aviation Department at Brooklands said in the libel suit he brought that he had been employed by the company four and a half years and, until this letter, nobody complained of his conduct, but now notices he put up were defaced with such words as 'Bloody German'. His Counsel stressed that a man could not help having a German name. The plaintiff had no association whatever with Germany; he was a Scot and his father and grandfather were Scotsmen.

His Lordship having favourably summed up, the jury returned a verdict for the plaintiff, assessing damages at £300.

As a young man Muller had worked in Canada as a railway ganger, served in the South African War, and spent nine years in India as an engineer. Returning to England in 1911 he was attracted by the aerial

Three Vickers figures – Maxwell Muller (left) the aircraft department manager, Maj Herbert F. Wood (centre) who started the aviation department in 1911, and Harold Barnwell (right) the great pilot-designer.

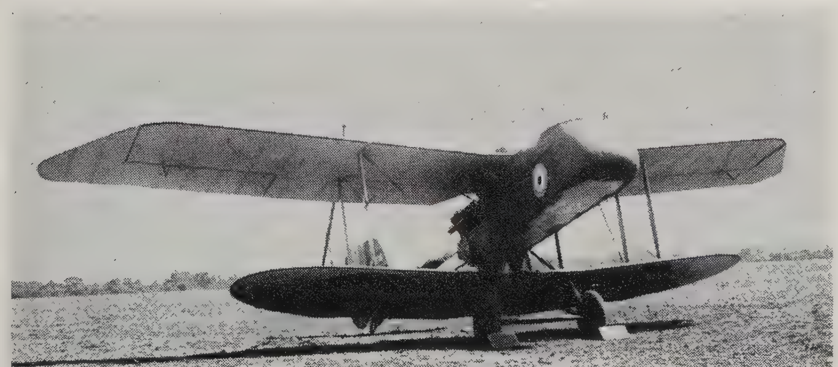
activity at Brooklands and helped Robert Macfie to build a 26 ft span aeroplane which was the forerunner of all single-seat scouts. This led him to join Vickers at Erith in 1913, and in that year he, Rex Pierson, and Tommy Duncan – the inventive gun genius who schemed Challenger's interrupter gear – learned to fly at the Vickers School, taught by Harold Barnwell. Pierson's assistant, Henry Knowler, in later years said of Muller: 'Major Wood had got impatient over delay in delivery of B.E.2cs at Weybridge, where Hearle had been trying to get the factory built and simultaneously meet production targets. Inevitably these were not met, so Wood, who had no judgment of men nor sense, and was the most difficult person imaginable, sacked Hearle and told Muller to take over,

Production S.E.5s had blunter wing-tips, and early machines had huge windscreens giving semi-enclosure but these were later changed for small transverse Triplex panels. (*Fleet Air Arm Museum.*)

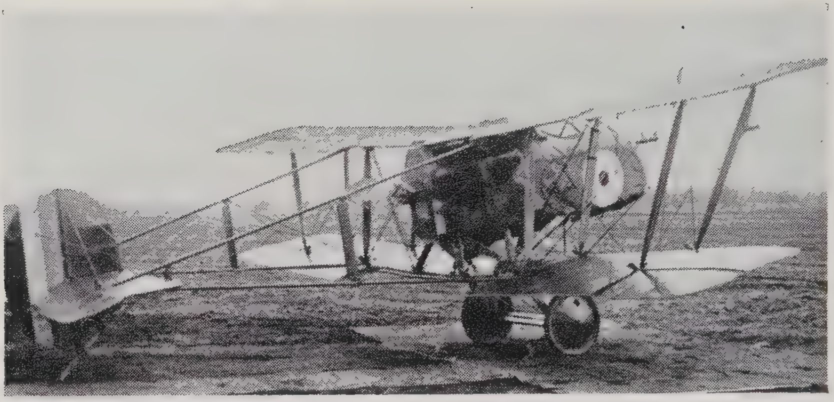
The stumpy little Vickers F.B.19 Mk I is shown being started up at Brooklands with Harold Barnwell in the cockpit and his assistant, Stanley Cockerell, leaning against the wing. Stagger was subsequently introduced in the Mk II. About 50 of the two versions were built. (*Vickers Ltd.*)

and he naturally got the credit for Hearle's work, though certainly got a move on with a subsequent order for S.E.5s. Muller only agreed to take over at Weybridge if he could have Archie Knight as foreman and Trevor Westbrook, who was in my stress office at the time, as his assistant. I found Maxwell Muller very pleasant and friendly, always co-operative with the design side in the person of Rex Pierson and myself; but you can guess he was a diplomatist in being able to handle the very difficult Bertie Wood.'

During the last few years since Howard Flanders' time, many interesting designs had stemmed from Vickers. Most were the combined work of Rex Pierson and Harold Barnwell, whose E.S.1 and E.S.2 rotary-engine



One of the most grotesque Farnborough aeroplanes was the F.E.9 two-seat fighter reconnaissance pusher powered by a 200 hp Hispano-Suiza engine. The huge aileron balance caused trouble, and Capt Geoffrey T. R. Hill made numerous tests with variations of aileron and rudder in the summer of 1917. (*Imperial War Museum.*)



The Vickers F.B.26 Vampire in earliest form had a flat radiator behind the 200 hp Hispano-Suiza engine, but inevitably cooling was inadequate.

fighters had developed into the F.B.19 which went into limited production for the Middle East where performance and perfection were not so essential as on the Western Front. Following Challenger's earlier pusher designs, came the F.B.12, which was generally similar to Farnborough's F.E.8 but intended for the defaulting 150 hp Hart engine, so was temporarily fitted with a Le Rhône of only 80 hp. Flown in June 1916 to get an idea of its handling qualities, the RFC commented in the following month with sufficient favour to justify production design as the F.B.12c; but continuing failure of the Hart caused it to lose out to the D.H.2 and F.E.8. However it led to the F.B.26 as a slightly larger development of 31 ft 6 in span, which exhibited the same contemporary pusher design-thought as Farnborough's recent two-seat F.E.9 fighter. Both were powered with the 200 hp Hispano-Suiza.

First flights of the F.B.26 were by Harold Barnwell, and since the machine followed the previous proved pattern, handling showed no snags; but as

To overcome cooling problems with the Vickers F.B.26 the radiator was tried in two blocks under the centre-section as seen here. Later when a new wing structure and modified tail were fitted twin radiators were mounted each side of the nacelle. A trench fighter variant in 1918 was powered by a 230 hp B.R.2. (*Imperial War Museum.*)

might be expected, cooling was inadequate because its S.E.5-type radiator was bluntly mounted at the rear of the engine. This led to separate radiator blocks each side of the top-wing centre-line, opportunity being taken to rebuild the wings with wider centre-section and slightly smaller lower wing, adjusting the tail areas proportionately. On 22 July Capt J. T. B. McCudden, MC, the latest notable air ace but temporarily fighting instructor at Joyce Green, flew it in this guise, and also the current derivative of the F.B.16 tractor engined fighter, which had gone through many metamorphoses from the original designed for the 150 hp Hart, and was now a squat, confidence-inspiring biplane, with the currently favoured larger chord top wing. Powered by a 150 hp Hispano-Suiza, it had been intended as competitor of the S.E.5, but disaster struck the prototype the previous December while being tested by Capt Simpson. Following a couple of loops and a third much lower, the machine dived straight into the ground from 50 ft, probably due to stalling. A replacement F.B.16A prototype had recently been at Martlesham where its performance proved practically identical with the S.E.5, but RFC pilots were critical of the over-compact engine installation partly tucked under the centre-section. McCudden agreed that despite good aircraft performance and flight handling, the engine made it impracticable – nor was his comment that the pusher F.B.26a 'was very much the same as an F.E.8 to fly' sufficiently encouraging to press for its production. However, the excellent view for the pilot, in his high location just in front of the wing leading edge, suggested possibilities as a night-fighter, and led Vickers to tackle a side-by-side two-seat pusher F.B.25 equivalent of Farnborough's night-flying N.E.1 – yet another variation of standard components in the form of a three-bay pusher affording big area and slow landings facilitated by an unusually wide-track undercarriage with wheels hydraulically sprung beneath the innermost struts of the wide centre-section.

Two relatively conventional Vickers biplanes, the attractive single-bay

The Vickers F.B.24 fighter-reconnaissance biplane was built in a number of forms. Seen here is the F.B.24C with conventional fuselage position and Lorraine-Dietrich engine.

The experimental Vickers F.B.24E with upper centre-section attached to the fuselage top longerons, and with the pilot in the rear cockpit.

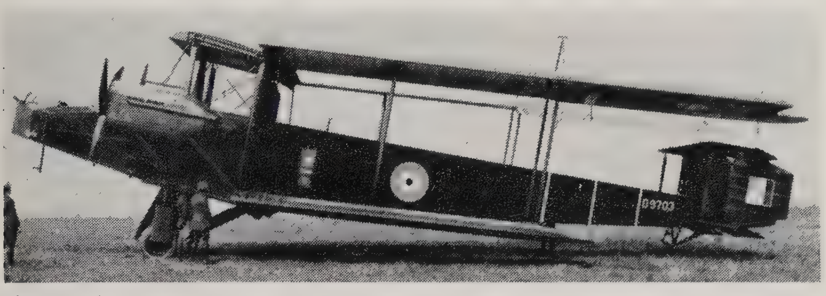
F.B.14 and slightly smaller two-bay F.B.24 had been designed as two-seat fighter reconnaissance biplanes, and 150 of the former intended for eventual 160 hp Beardmores were built as airframes. Several other engines were tried including the Eagle IV in the F.B.14D version, but it had become outclassed by the Bristol Fighter on going to Martlesham in March 1917. Its successor the F.B.24, with currently acceptable larger top wing than lower, was suffering the delay of all aircraft for which the Hart engine was intended. Requirements for Hispano-Suiza, Sunbeam and Rolls-Royce Falcon were too urgent to allocate any as alternative for an appropriately redesigned machine, but eventually it went with no great urgency through several major modifications of wing disposition, size, and type of engine, eventuating as the F.B.24G of too little value for Service adoption.

6

The Air Board had issued specification A.3(b) for a night-bomber carrying a crew of three, with bombs and gear weighing at least 3,000 lb. It stated that: 'The gun-layer must be able to lie or crouch down when sighting or releasing bombs, and easy communication for steering purposes is to be provided between pilot and gun-layer. If possible, bomb racks to be arranged to be quickly detachable. Strength factors with full load to be not less than 5 on front truss and 4 on rear truss.' The document was almost immediately revoked by the Air Board, but the new Controller of the Technical Department, Major John Buchanan, a wiry little Scot of great determination, managed to reverse the decision, and accepted tenders both for this machine, and for smaller bombers to specification A.2(b) where the required range was 500 miles at 115 mph at 15,000 ft carrying 500 lb of bombs and gear together with two guns and ammunition.

The less ambitious specification attracted Rex Pierson, and he immediately went to the Air Board to discuss his proposals for a twin-engined bomber, the F.B.27. 'I well remember talking over the project for this aircraft with Buchanan at the Air Ministry,' he said 25 years later. 'Between us the layout of the machine was hatched out on a piece of foolscap

paper, and I can vouch for the fact that the craft, as first flown, was reasonably like that preliminary free-hand sketch.' As a first step in its design he persuaded Major Wood to transfer the drawing office staff of about 100 men and women at Knightsbridge to new offices at Weybridge so that he could work in closest co-operation with Maxwell Muller.



The Handley Page O/400 had a short span lower wing to clear the ground when folded, and the overhang lift wire was similarly located to clear the top tailplane. Wings were always folded before housing, and a special hydraulic jack trolley was used to lift the tail which required 20 men to lift it with wings extended. (*S. T. A. Richards.*)

Concurrently Frederick Handley Page was discussing a great four-engined bomber design to meet specification A.3(b). Like the O/400 it was considered necessary to have folding wings because no hangar was big enough for machines of such size, and whether big or small the lightly laden aircraft of that period, when tethered in the open, often blew over if there was any great wind. But H.P.'s proposed machine was to be a breathtaking advance in size, spanning 126 ft, matching the great new bombers reported from Germany as replacing the Gotha. Although a machine with long top overhang giving a span of 142 ft had recently been constructed by Fairey Aviation to the design of C. J. H. Mackenzie-Kennedy, who had secured a constructional contract on the strength of his association with Sikorsky when the latter built his great four-engined biplane in 1913, it was clearly grossly underpowered with four tandem-paired British-built Salmson water-cooled radials of only 200 hp, and nobody had any great faith in the outcome.

The Kennedy Giant was taken to Northolt for its flight trials which were made late in 1917 by Lieut Frank T. Courtney who found that the tail units must be increased in size and that performance was inadequate with only 800 hp. Thereafter it remained derelict, as the design had long been outdated by the Handley Page.

For his new V/1500, Handley Page was going for maximum horse-power in a twin-engine design. Evolution of the O/100 to the O/400 had brought home the lesson that it paid to go for the biggest possible engines, and to that end Handley Page was assured by Henry Royce that a new Rolls-Royce of 600 hp, the Condor, would be available in time for next year's offensive. The history of engine development had shown an unconscionable time might be taken, so an alternative scheme for four Eagle engines was made, following Kennedy's lead in putting the engines in tandem each side. It was identical with the reported arrangement of Germany's new giant bomber of nearly 140 ft span, the Zeppelin Werke Staaken R.IV, which had just been spotted flying operational trials on the Eastern Front and was intended for raids on London.

The factory at Cricklewood was still being extended, and over 1,000 men and women were employed on O/400 production, full of enthusiasm at the carefully leaked rumour that their splendid bomber was being adopted by the Americans as a primary operational type. As space was at premium at Cricklewood, and the small D.O. busy with design of a compact attractive two-seat reconnaissance seaplane, the R/200 – largely designed by Harold Boultbee and Leslie J. H. Richards – arrangements were made with the Harland and Wolff shipbuilding yard to build the V/1500 in Ireland, and a design office was opened in Belfast. George Volkert recollects: 'Until 1917 we were virtually a project design team – the first production drawing office being formed in the new works at Claremont Road towards the end of the year. During my and Arcier's absence in Belfast with four seniors, we got the first V/1500 flying within six months of the start. Stressing was done by a Naval officer, Tom Wilson; and H.P. himself did the check

An unexpected breakaway from Handley Page big aeroplane association was the neat 36 ft span R/200 two-seat naval reconnaissance seaplane, flown from the Welsh Harp at Hendon by Gordon Bell before he delivered it to the Isle of Grain. A second machine had a land undercarriage. (*S. T. A. Richards.*)

stressing when he came across to Belfast every week-end after a busy week at Cricklewood. We all worked from 9 a.m to 9 p.m. for six days a week and then till 1 p.m. on Sunday. One benefit was the purchase of Irish hams which H.P., and any others of us who could occasionally make the journey, took home to our half-starved families in England.' Indeed, nutritious diet in England was at minimum level. In the cities many went hungry, and even nettles were used to eke out meagre supplies of green vegetables. Only if one had friends in the country was there opportunity of an occasional good meal.

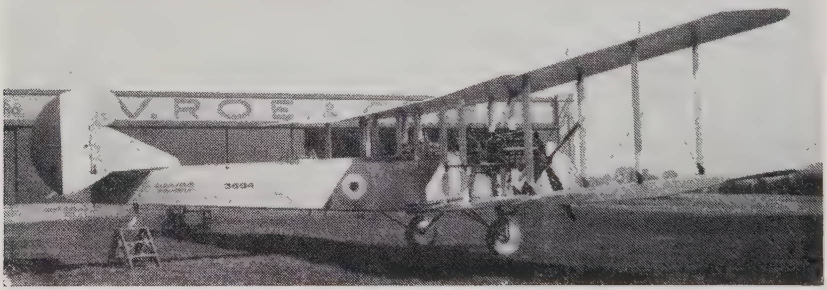
One of the team at Belfast was Leslie Richards' 23-year-old brother, known from his initials as 'Star', who had joined Handley Page in 1915 on completing apprenticeship with the Great Western Railway and a year's experience in their Swindon drawing office. H.P. shrewdly put him in the

An experimental Handley Page O/100 with four 200 hp Hispano-Suiza engines in tandem pairs to secure practical experience before adopting the arrangement for the big V/1500. Installation was by Farnborough technicians under the direction of Maj P. Bishop. The small aircraft is an S.E.5a. (*Imperial War Museum.*)

Cricklewood shops for some months to gain aircraft experience before making him his personal assistant, but recognizing his flair for design, sent him with Volkert to Belfast. Richards considered that the outstandingly brilliant Francis Arcier took equal responsibility with Volkert throughout the war, and that theirs was an extremely happy and productive partnership. Assisting in the Handley Page six-man team were 20 draughtsmen from Harland and Wolff. 'Under H.P.'s direction I had originally drawn the V/1500 on squared paper as an instruction sheet for the D.O. to develop,' Richards told me. 'When I went to Belfast, Volkert and Arcier, with the experience of the O/400 behind them, were able to scheme the V/1500 in one harmonious concept, so that we were able to make the drawings straight away in detail. The object was to design a bomber double the weight of the O/400 and if possible carrying two and a half times its load at a top speed of 100 mph. The wing area was 2,800 sq ft, and the ailerons alone equalled the wing area of a contemporary fighter. We followed the general design practice of the O/400, but the entire rear structure of the fuselage was of McGruer circular spruce longerons and struts built on their patent system of spiral-wound laminae because by this stage of the war it was necessary to make spliced and built-up wooden components owing to the shortage of long lengths of spruce. Tremendous

efforts were made to save weight. Thus instead of making a huge cylindrical fuel tank of 1,000 gallons capacity, Volkert made one which was cross-braced within and shaped to the exact contour of the fuselage.'

To secure practical evidence of propeller efficiency using separated tandem configuration, one of the O/100s, No. 3117, was tested at Farnborough with four 200 hp Hispano-Suizas after Arthur Fage, ARCSC, made mathematical investigation of the loss of efficiency based on the 'Momentum' theory. Combinations of propellers in tandem pairs were designed to give identical thrust, and the aircraft performance theoretically examined, resulting in the hitherto unrealized conclusion that efficiency depended not only on blade section and pitch angle, but that inflow varied appreciably with diameter and whether the big propeller was the front or rear one. At best the efficiency of the rear propeller would be about 0·9 of the front one in horizontal flight, and only 0·75 when climbing. Model and full-scale co-ordination took weeks of urgent work, for it was essential that this expensive gamble of a big bomber would prove a success.



The Avro 529 in front of A. V. Roe's splendid new experimental shop facing Southampton Water near Hamble. The twin 190 hp Rolls-Royce Falcons were mounted at mid-gap and uncowled, disturbing the elevator control.

When the mounting public feeling in favour of what was popularly pronounced 'reprizzles' against bombing of Britain ultimately convinced the Government that the Air Board must place orders for bombers, A. V. Roe and Airco were selected to build smaller day-bomber prototypes than the Vickers in view of their previous instructive experience with twin-engined machines. As recently as April Avros had completed their Admiralty order for the Type 529 long-range twin, based on the 523 Pike of the previous year, but it was not wholly successful as elevator control was poor and ailerons heavy. Experiments were being made with novel methods of aerodynamically balancing the ailerons by connecting them to separate auxiliary surfaces which Reg Parrott had devised, obtaining Patent No. 129,696. This led to a narrow little aerofoil mounted above and a few inches forward of the hinge line of a conventional unbalanced aileron as simpler than constructing a projecting integral forward balance and back-set hinges. In the Hamble works it became known as Parrott's 'Park Bench'.

Soon after settling at Hamble, Alliott Roe relinquished much of his

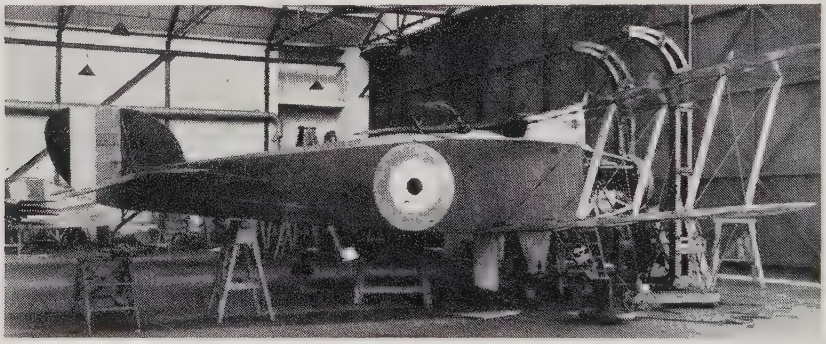
The Avro 504 was built in greater numbers than any other pre-war design, and both as the 504J and the 504K became the incomparable trainer of thousands of pilots. In later years it was to give some 30,000 people flight initiation with joy-rides.

control on design, leaving it to Roy Chadwick as chief designer, and 'Jock' Ratcliffe became chief draughtsman, but as F. W. Vernon had left to join the Admiralty Torpedo Establishment at Portsmouth, Ratcliffe was also made responsible for stress calculations, performance work, and flight-testing. Soon his task was eased when Harold Rogerson joined the company to deal with performance and airscrew design and presently became head of the department. 'Roy Chadwick,' affirmed Ratcliffe, 'was

Alliott Verdon Roe, born in 1877, made his first full-scale aeroplane in 1907 After powering with a 24 hp Antoinette he managed to make a few hops in June 1908 blissfully unaware that a later pundit would decide that to be airborne was not flight. (*Flight Photo.*)

the master-mind behind most, if not all, design work during World War I, and particularly the latter half.'

But the past still played its influential part. Only recently had drawings been completed for what was to become the world-famous 504K based on the elegant pre-war machine which was the highlight of A. V. Roe's earlier life. Engine mountings and cowlings were redesigned to accommodate any type of rotary, and details simplified to aid production and facilitate assembly in convenient units. Half a dozen patents that year testify to Roe's high regard for this machine. Many 504 parts were incorporated in his Type 531 single-seat fighter currently being built. Perhaps A.V.'s disenchantment with full design responsibility had begun with the Type 530, a two-seat competitor of the Bristol Fighter, for it was described as 'a brute of a machine to fly and very dangerous'. That was a slap after universal praise for the 504 series.



The Avro 530 was to have had a 300 hp Hispano-Suiza engine, but used a 200 hp unit because of the supply bottleneck. A balanced bigger rudder and longer fin replaced those shown but flying characteristics remained unsuitable probably due to flow constriction at the centre-section.

At last with a free hand in designing the twin-engined bomber Type 533, soon named the Manchester, Chadwick plunged for maximum power as the two 190 hp Falcons in the 529 had only given 100 mph at ground level; but Rolls-Royce Eagle production was fully allocated and he was persuaded to redesign for the A.B.C. Dragonfly radial on which Sir John Weir had staked everything.

Geoffrey de Havilland was of different mind. Like Chadwick with the Pike, he had been instructed to bring the D.H.3 up to date. His intention was simply to replace the Beardmores with 230 hp Siddeley Puma engines similarly mounted as pushers using a new airframe – for after completing tests at CFS in July 1916, the original D.H.3 had been dumped engineless behind the Airco hangars at Hendon where it steadily deteriorated, and only recently had been burned because its storage space was required. The new machine had slightly longer span, and was stressed for greater all-up weight in complying with the general terms of specification A.2(b). A contract was received for four prototypes.

De Havilland was in a quandary because of other things. The D.H.9, with its Puma irrevocably derated from 300 hp to 230 hp, was a sad disappointment. On 14 November Douglas Haig requested all orders for D.H.9s to be reduced so that they could be limited to 15 squadrons. Like the B.E.2c earlier in the war, the country was building an already outclassed machine.

Concurrently great play was made in the Press, aided by every artifice of American trumpet-blowing, that the USA had built a revolutionary 400 hp engine, named the Liberty. With Colonel Edward A. Deeds as catalyst, it had been designed by Major Jesse G. Vincent of the Packard company in collaboration with Major Elbert J. Hall of the Hall-Scott

Converted from a D.H.9 to a D.H.9A, B7664 was built by Westland and fitted with a 375 hp Rolls-Royce Eagle in a nose intended to accommodate the eventual Liberty. A bush in the background is responsible for the apparently distorted shape of the rudder balance.

company, two outstanding engineers who met for the first time on 29 May, and by the afternoon had drawn an eight-cylinder vee-engine. By 4 June five draughtsmen had completed the design. On 3 July the first sample engine was delivered to the Bureau of Standards, accomplishing initial running 20 days later, and was flown for the first time on 29 August in an L.W.F. biplane while the 50-hour bench test was still being run at a rating of 314 hp. By 13 August a twelve-cylinder version was under test. On a great wave of enthusiasm and big thinking, the USA placed contracts for its production in thousands. With the Rolls-Royce demand exceeding supply, here was possible solution to a powerplant for British day-bombing requirements. The D.H.9 must be modified to take the Liberty – for the location of pilot and gunner close together was operationally superior to the well-proved D.H.4. At this point came strong pressure from the Air Board to hasten the new twin-engined D.H.10, and with only 50 draughtsmen at his disposal de Havilland could not accomplish both urgent tasks.

'I joined the Aircraft Manufacturing Co in the summer of 1917,' J. J.

'Johnnie' Johnston told me. 'When DOR asked de Havilland to push on with the D.H.10, I was scheming modifications to the D.H.9 to adapt it for the Liberty, and was told to gather up my sketches, layouts, and drawings and hurry to Yeovil where Robert Bruce was to take responsibility for the conversion because Westland had made a great success of building D.H.4s and D.H.9s. The converted machine was named the D.H.9A, but it was in fact a complete redesign of greater span, with 3 inches added to the wing chord, increasing the wing area from 434 sq ft to 486·7 sq ft, and the all-up weight initially greater by some 600 lb to carry the bomb-load and fuel required. As a first guide, we modified B7664, a standard D.H.9, and fitted a 375 hp Eagle as trial installation because the Liberty would not be available for some months. Using a four-bladed propeller, consisting of two single propellers bolted together, it was flown at Yeovil by B. C. Hucks.'

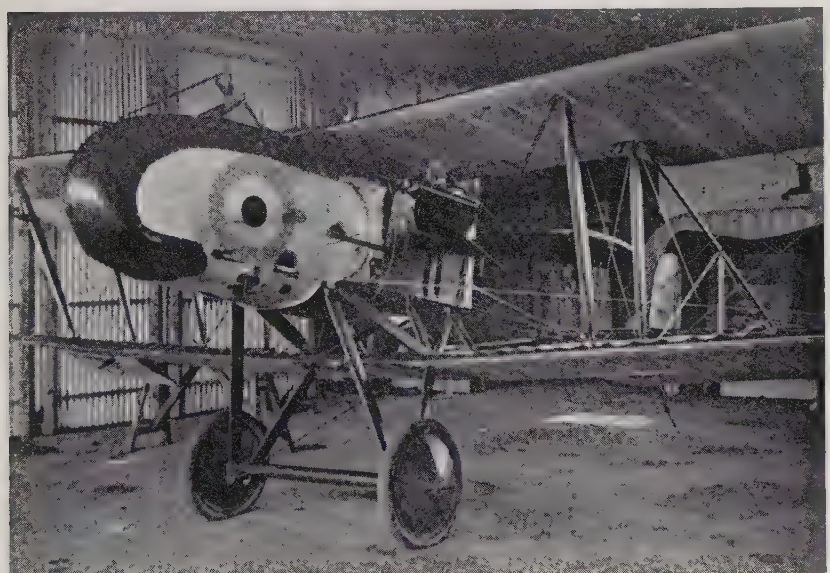
There was one other twin-engined bomber biplane contender. In August John North had been appointed designer to Boulton and Paul Ltd of Norwich. The B & P works had been a familiar landmark in Norwich since 1873, though actually founded in 1797 by Alderman William Moore as an ironmonger's shop which in 1868 was sold to John Boulton and turned into a horticultural woodworking factory managed by J. J. Dawson Paul, becoming Boulton and Paul in 1873. Contracts for hospitals and bungalows during the Boer War firmly established it, and when the Great War broke out, the firm under the management of W. Henry ffiske became engaged on wooden building construction for the Government. J. J. Dawson Paul was now governing director, and in conjunction with the Howes Coachbuilding Works had established an aircraft factory managed by ffiske's son Geoffrey, a keen yachtsman largely responsible for the first hydroplane hull and engine built in this country. Considerable production of F.E.2bs and then of Camels necessitated taking over the Cavalry drill ground at Mousehold Heath, just outside the city. Spacious erecting shops were built, and the aircraft tested on the Heath, under care of Stanley Howse, by Capt Howard Pixton, of one-time Schneider fame.

Henry ffiske now retired as managing director, but J. J. Dawson Paul continued as chairman, investing executive responsibility in a committee of management comprising his son Capt J. Dawson Paul ex-RFC, William ffiske, Geoffrey ffiske, and Stanley Howse who was then elected to the board.

John North at 25 was a commanding figure, towering like Handley Page and Fairey above his colleagues, though handicapped by a nervous twitch. With full technical control under his command, and an ex-mathematical master Otto Glauert, brother of Farnborough's Herbert Glauert, as stressman, he vigorously commenced work with several priority fighter schemes and a subsequent twin-engined bomber to A.2(b) specification. His chief designer was M. Boudot, whose Pup-like 100 hp Monosoupape Scout, built by Nestler Ltd, had encountered disaster in the early spring when its wing fabric stripped while being 'stunted' at Hendon.

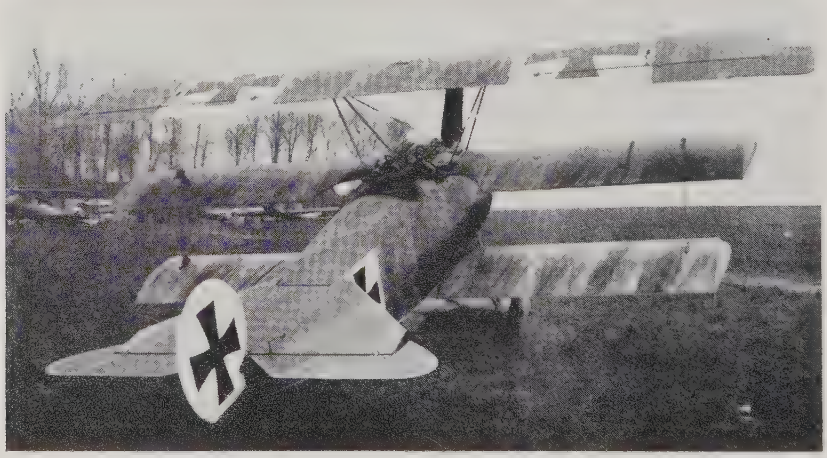
Among the great lists of casualties that summer was Major Hubert Dunsterville Harvey-Kelly, DSO, Royal Irish Regiment, attached to the RFC. He was the last of the pilots who had flown a Cody, and on the outbreak of war, piloting B.E.2a No. 347 of No. 2 Squadron had been the first to land on the Continent. Within twelve days he showed the way in aggressive tactics by diving repeatedly at a Taube and forcing it to land. His venturesome, almost reckless leadership had inspired many a young man to play his part in founding the great RFC tradition, and among these was his observer, Sholto Douglas, all undreaming of his own great future achievements in military and civil aviation.

Not long after, there came the tragic death of Harold Barnwell, killed while flying the Vickers Vampire F.B.26. Capt W. G. Barker, already renowned with Major Bishop as a great Canadian fighter pilot, had just flown the machine. Harold Barnwell then decided to make a short flight, though he had only now returned to Dartford after delivering the last of three machines he had been ferrying that morning from Brooklands to Farnborough. Climbing the Vampire several thousand feet, he made two or three loops, shot up the airfield and pulled up in a 2,000 ft zoom, when the machine entered a right-hand spin. Instead of flattening out, it went straight into the ground, and Barnwell was instantly killed. Examination of the wreckage showed all controls intact, and Capt Barker corroborated



The prototype Vickers F.B.26 with which Harold Barnwell fatally spun into the ground on 25 August, 1917. The small diameter high pressure tyres were typical of Great War aircraft and caused much trouble in soft ground. (*Courtesy C. F. Andrews.*)

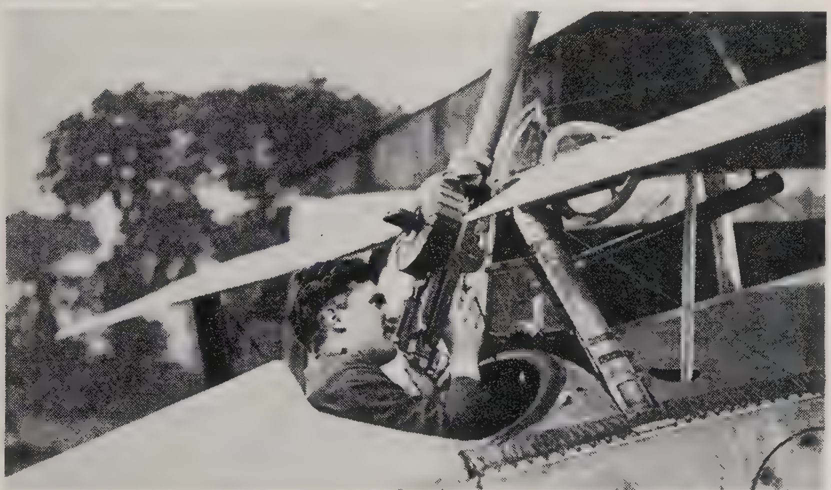
that the machine had seemed in perfect order; but it was known that Harold Barnwell had not been well of late and had complained of giddiness. So at the age of 38 passed a great pioneer pilot and clever designer. Indeed, it was he who had initiated his brother Frank, the Bristol designer, into aircraft construction as far back as 1908. Said a friend: 'His tiny Scout built at Joyce Green was the fastest machine of its day. Although not adopted as a Service type, it displayed so much promise that it was recently arranged he should take up designing as his chief occupation, and leave the firm's regular flight-testing to others. If Harold Barnwell had been possessed of ambition, there is no telling to what high position his abilities might have carried him, but he was obsessed by an invincible contentment with his lot, and could not be induced to struggle with his fellows in the race for what is commonly supposed to be success in life.'



The revolutionary cantilever-winged Fokker Dr.I 110 hp triplane attained 103 mph and could climb to 1,000 metres in 2·9 minutes. Span was just under 24 ft and all-up weight only 1,289 lb. German pilots regarded it as ideal, but our Ministry of Munitions reported 'the Dr.I exhibits few instructive features'. (*A. R. Weyl.*)

For every test pilot killed in England, young men were dying by the thousand in the trenches, on the sea, and fighting in the air. Even the Sopwith Camels were finding their match against a new Fokker cantilever triplane, flown that late summer and early autumn by Werner Voss, Manfred von Richthofen, and others of *Jagdgeschwader Nr. 1*. Inspired by the Sopwith triplane which had so brilliantly outclassed the hitherto successful Albatros D.III, a number of German constructors had been ordered to produce experimental triplanes, but only the cantilever Fokker Dr.I came up to expectations after initial rejection as the V.3 in which there was wing flutter attributed to elimination of interplane struts, and these were therefore fitted for subsequent versions. Nevertheless some German pilots still viewed the novel wing with suspicion, and they were soon justified.

Successful fighter pilots of the German and French Air Forces had long been used as propaganda by publicizing their successes as Air Aces, a term most of them mentally rejected, knowing they were caught in the national web of war and doing the duty imposed on them, as well as fighting to save their very lives. Somewhat reluctantly the British cautiously began to build up the public image of their own pilots in similar fashion. Flying was so new, this war so vast, so terrible, that fighting in the great skies above France and Flanders had to the stay-at-homes an almost romantic appeal. Each side was proud of its air heroes – and none should deny their justification, for these young men were modern equivalents of the knights of old, fighting a more individual war than the massed ranks of opposing armies below: yet one and all, whatever the medium of battle, typified the universal nature of the male defending his territory.



William Avery Bishop in his Nieuport Scout of No. 60 Squadron RFC shows the operation of his gun. With this machine he gained his VC by attacking an enemy aerodrome single-handed, shooting down three machines and damaging others. (*Imperial War Museum.*)

Albert Ball had gone – last seen diving his S.E.5 into a great cumulus while fighting a German single-seater late in the evening of 7 May, 1917; James Thomas Byford McCudden, MC, was the rising star in the same No. 56 Squadron where Ball had been Flight Commander; close on his heels was Edward 'Micky' Mannock, recently promoted Captain and awarded the Military Cross; but the premier victor of all was 'Billy' Bishop VC, the 23-year-old fair-haired Canadian, credited with 45 hostile aircraft shot down, who in mid-August was promoted Major and awarded a bar to his DSO. For some months he had been in Canada on a recruiting campaign. In November he went to Dayton, Ohio, to test the new Liberty engine, and was dismayed to find that the much-vaunted American

production of aircraft was suffering far more disastrous set-backs than anything experienced by British shadow factories.

The confusion, cost, and obvious lack of completed machines presently led Bishop to great indiscretion. Speaking to a Canadian club in Montreal he said: 'Germany will have nothing to fear from the US air fighting forces during the coming spring, because the American aircraft programme is far behind schedule. France would find it impossible to enlarge her forces during the coming half-year, but Germany, knowing America's intention, has greatly expanded her Flying Corps in an effort to gain supremacy in air warfare. Consequently during the next few months Great Britain will have to face the most terrible time from the point of view of war in the air.' It was to bring him the sharpest of reprimands.

Bishop was not alone in his criticism, nor his fears. Issue of the American requirements for Specification No. 1003, 'Military Pursuit Airplanes', had caused concern by its naïveté. 'It indicates how much behind Europe are America's aeronautic officials in their knowledge of war requirements,' said C. G. Grey. 'We expect rather a lot from America in this war, and more from her in the air than on the ground, because air fighting affords even greater scope for the peculiar initiative and individuality of the American than does infantry work. It would be a real tragedy if the splendid human material which America can supply were wasted by being ineffectually equipped.'

The Allies had been promised 'thousands of battle planes darkening the Western Front', but when the USA declared war on Germany in April the Aviation Section of the Signal Corps had not a single suitable aeroplane either for fighting or reconnaissance. Only the Curtiss JN-4 was in quantity production, thanks to urgent British demand for two-seat trainers. To equip their own forces quickly, the best course to the Americans seemed the reciprocal of adopting the latest and best British operational aircraft rather than French, particularly as this would avoid language and dimensional difficulties. Foreseeing the need, Major Wood had sent Archie Knight and Frank Hearle in January to the USA to push the merits of the obsolete Vickers pusher Gunbus, and it was lack of success with this mission which finally led to strong words from Wood in criticizing production, resulting in Hearle's return to his old friend de Havilland when he discovered that American inclination was towards the D.H.4, Handley Page O/400, and S.E.5. But the D.H.4 had only begun combat life on 6 March when No. 55 Squadron flew them to France – for there had been tremendous delay since ordering by the War Office on 11 July, 1916. Yet by now it was being rigorously used and proved well-liked, but the Americans proposed fitting the Liberty instead of the Rolls-Royce, blind to British experience that every major change resulted in delay.

By Senate directive the American automobile industry was instructed to organize aircraft production, for their pioneer aeronautical professionals were regarded as no more than enthusiastic amateurs when it came to mass construction. Whatever their skill in turning out thousands of

identical automobiles, there were inevitable surprises for the 'experts' of an alien industry when they discovered that an aeroplane was constructed to marginal limits of strength, rendering the tolerances of car chassis and body construction, as well as their methods, quite unacceptable. When the first sample British D.H.4 was received at the end of July by the headquarters of the technical staff of the Aviation Section at Dayton, Ohio, it became the focal point of an army of production engineers who soon envisaged numerous engineering changes to make the machine, in their eyes, more easily fabricated – although it is interesting to find that the Germans of that time, from inspection of captured British aircraft, particularly admired 'the working out of the single parts as to quantity manufacture, which rules indisputably more among the enemy than us for ease of production. They have in the whole aeroplane only one turnbuckle model, one size of stamping machine, holes and pins. The stampings themselves can be manufactured much quicker in quantities by this better utilization of machine work', but though they conceded British aeroplanes were often superior to theirs, it was explained that this was because 'Frenchmen and Englishmen attain only the lightness of their machines through savings in weight in some of the most dangerous places, and there too the solid German industry cannot be induced to do likewise.'

The American-built D.H.4 with Liberty 12 engine was ordered to the tune of 9,500 and the first production machine was delivered by Dayton-Wright some three months after the first flight of the experimental prototype. (*Smithsonian Institution.*)

The sample D.H.4 was adapted to take a pre-production hand-built Liberty, and the first flight with this combination was on 29 October. Meanwhile orders by the thousand for the D.H.4, renamed with the usual ballyhoo 'the Liberty-Plane', were handed to three main contractors: the Dayton-Wright Co, the Fisher Body division of General Motors, and the Standard Corporation who also held a contract for 1,500 Handley Page O/400s powered by the 350 hp Liberty. Meanwhile the D.H.4s in British

use were exposing several deficiencies, chief of which was the interpositioning of the 67-gal fuel tank between pilot and observer, but were being ordered in swiftly increasing quantity, particularly from Westland who were building this machine at the now standard price of £1,424 each without engine or instruments, but including flight-test and installation. Its Rolls-Royce Eagle VIII cost £1,622 10s.

The D.H.4 had also been standardized by Russia prior to the Kerensky revolution, and it still seemed the new Russian Republic's intention to continue war with Germany. Not only had 50 D.H.4s, powered with the 260 hp Fiat, been ordered, but a Russian factory was being planned for further construction of this type, and Airco sent two engineers, Wilkins and Wallace, to explain the drawings and production methods. In his book '*D.H.*'*, Martin Sharp says: 'Wilkins brought back an artistic Russian *émigré* named Voyavodski to assess his claims for an alternative streamlined monoplane for which high figures of performance were obtained in the wind-tunnel which Airco now possessed. But when Hagg suggested testing a biplane model which likewise had no windscreen *and no undercarriage* this gave even better figures.' Nevertheless under the name Woyevodsky, N, a British patent application was made for 'An aeroplane constructed so that all longitudinal sections of the machine are aerofoil sections of uniform camber but of constantly varying length and depth, the body portion accommodating pilot and engine thus forming a supporting surface.' A retracting undercarriage was also patented as part of the scheme.

8

Changing political climate in Russia was being closely watched both by Allies and enemy. It came as practically no surprise that on 8 November Lenin and Trotsky seized power from Kerensky. The new Russian Republic had been fighting with little help except criticism from their French and British Allies. The new Soviet, a body in Petrograd representing the workers and soldiers, had been clamouring for an international conference of socialists at Stockholm, and Kerensky had done his best to induce his Western Allies to agree but, frightened at the threat of Marxist socialism, they refused. With peace apparently beyond grasp, the limit of Russian endurance had been reached. It was then that the Soviet took over, pledged to make peace regardless of the Allies. It had the effect of fraying nerves still further in Britain, and led the worried Government to pass a Bill establishing a Director of Information, under the Prime Minister, and a Ministry of Reconstruction to show that peace might not be far away. But in fact the Germans knew that now was the hour in which they must make all-out effort to win before the Americans could take the field. British opinion in general held that the war would be won by the Allies in 1919 – and to that end all design and production of new aircraft was directed. A few analysts believed that the war would end a year earlier.

* Published by Faber & Faber, Ltd.

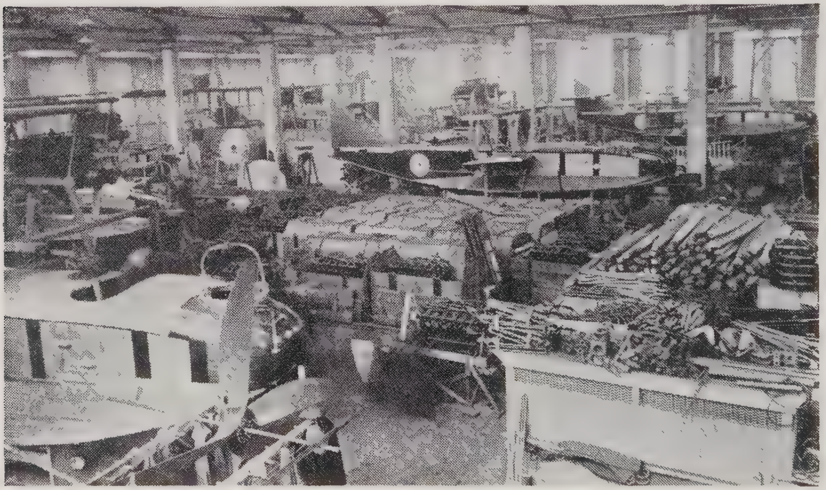
'In the air the enemy is steadily losing any title to supremacy,' declared one assessment. 'Allied machines are improving, and supplies increasing at rates which the Central Empires cannot hope to rival. The German air raids are in a manner effective as the public are disturbed from their attitude of detachment from the troublesome war, but that cannot bring the enemy nearer decisive victory in Flanders. Two things dominate the present state of war – man-power and *matériel.* The Central Empires have no new sources of personnel save young boys; on the other hand, we have vast resources of fresh personnel. Supply of *matériel* is a matter of great importance. A preliminary bombardment today uses as many shells as a year of earlier war. Our advances in France are largely the result of superior volume of fire; troops can only be driven from their positions by sheer weight of metal. Though there is plentiful raw *matériel* in the various countries forming the German Alliance, it is questionable whether they can make use of these resources. Thus coal is necessary in manufacture of steel, but equally for conveyance of material to steel producing plants. The transport of troops must not be reduced because the Krupp factories are short of material.

'In aeronautics, Germany has eliminated types which are not absolutely essential. Their resources are directed to building a few designs of special excellence, each of which has been drafted with a clearly defined object – for the German believes he knows the best machines for such differing duties as strategical reconnaissance, artillery spotting, long-distance bombing, and aerial fighting. Whether these types are well chosen or not, there is definite gain in reducing the variety being manufactured.

'The duration of the war and the decision as to ultimate victory remain entirely in the power of the Allies. It is certain we will be the victors. With unity and co-ordination of effort, there is little reason why the war should not end during the early summer of 1918.'

Even to those not in high places there were many signs that the tempo of war was to be relentlessly increased by Britain. Already the Rt Hon Winston Leonard Spencer Churchill had been 'by His Majesty's command, sworn Minister of Munitions,' replacing Dr Addison. In October Lieut-Gen Sir David Henderson, KCB, DSO, resigned the post of Director-General of Military Aeronautics, and Maj-Gen John Salmond, CMG, DSO, was appointed in his place. Universally popular in the RFC, Salmond had obtained his flying certificate at the Grahame-White School on 13 August, 1912, and on promotion to Major in August 1914 became first O.C. of No. 3 Squadron, then was gazetted Brig-General in 1916, and promoted to Major-General when the Training Brigade expanded to a Division. With the departure of General Sir David Henderson, whom *The Times* reported had been 'lent' in connection with schemes for an Imperial Air Service, his vivid assistant Maj-Gen W. S. Brancker, was posted to a Command abroad. It was also rumoured that Maj-Gen E. B. Ashmore, CB, MVO, a gunnery officer of renown, had been given responsibility for aerial defence of London. Said C. G. Grey happily: 'We've always had the best pilots in

the world; for a long time we've had the best aeroplane designs; we are rapidly acquiring the best system of aircraft production in the world; one is now fairly sure that we have the best staff in the world where purely military aeronautics is concerned. Even as Sir Douglas Haig's men in Flanders, after all their adversities, are now on the top of the ridge with sight of the promised land north and east, so military aeronautics has crossed the divide and is on the fair road to becoming the foremost and greatest Service of its kind in the world.'



Felixstowe F.5 production gets under weigh at S. E. Saunders Ltd under typically cramped conditions. Many F.3 components were incorporated, but the hull was planked overall. Their F.3 wings had horn-balanced ailerons. Production machines were too late for operational service. (*S. E. Saunders.*)

Unfortunately there were echoes that one who had done great things to build up the Naval Air Arm had been skirting the edge of trouble, for on 25 July a Mr William Casson had been accused at Bow Street of conspiring with Wing Cdr John Porte, RN, and Lyman J. Seely, alleging money had been corruptly paid to John Porte in respect of contracts made with the Curtiss Aeroplane Co of New York.

At the October Session of the Central Criminal Court the brilliant Sir F. E. Smith prosecuting as Attorney-General disclosed that orders for flying-boats were placed with the Curtiss company through Porte, using Casson as his agent and Seely as Curtiss agent. So large was the business that in 1916 orders were placed with Curtiss to the extent of $11 million, of which $5 million had been delivered, and commission totalled £64,000 – of which Casson regarded three-quarters as in trust for Porte, on whose behalf he had already made payment, retaining about £16,000 for himself. While giving evidence Porte collapsed from the effect of chronic pulmonary tuberculosis, and the case proceeded without him, during which it was

made clear by Commodore Murray Sueter that although he had initiated these Court proceedings, the proposal to purchase Curtiss flying-boats did not come from Porte, but from him, and both he and the head of the Contracts Department decided to negotiate through Porte because he was well known to the Curtiss company. After examining more witnesses in a further hearing, the Court ruled that the summons against Porte should stand adjourned *sine die*. Casson was committed to trial at the Central Criminal Court, and in November pleaded guilty to giving a gift to Porte, and was fined £500 on each of twelve counts. In effect he had to refund no more than the commission he had received.

Sagely C. G. Grey observed: 'It is common talk in the RNAS that the case would never have been brought to light but for the intrigue, growing from a purely personal quarrel, by which it was hoped that quite another person than Commander Porte would be implicated. That other person has come through unscathed, and Commander Porte may be considered, along with Messrs Casson and Seely, as more or less the victims of a vendetta in which they were not concerned. It is noteworthy that at no time was it ever suggested that the Curtiss company itself was guilty of corrupt practice.'

9

On Monday, 12 November, the long-rumoured Air Force Bill obtained its second reading. It was an historic occasion – for it set up, for good or ill, a third component of the King's Armed Forces. Part II of the Bill ordered that:

> For the purpose of the administration of matters relating to the Air Force and to the Defence of the Realm by Air there shall be established an Air Council consisting of one of His Majesty's principal Secretaries of State who shall be President of the Air Council and of other members who shall be appointed in such manner and subject to such provisions as His Majesty may by Order in Council direct.

Unfortunately Lord Cowdray, head of the Air Board, was left to discover from correspondence in the daily Press that the post of Air Minister had, without reference, been offered to Lord Northcliffe. It was an astounding situation. On 16 November most London papers contained a letter from Lord Northcliffe to Mr Lloyd George in which he declined the 'repeated invitations that I should take charge of the new Air Ministry'. He criticized the lack of unity of war control and failure to mobilize the entire man-power and woman-power of the country, or to introduce compulsory food rationing. In veiled phrases he indicated his abhorrence of certain unnamed members of the administration.

Acidly C. G. Grey commented: 'So far as his refusal of the post of Air Minister is concerned, Lord Northcliffe has conferred on British aviation another of those great benefits which we are accustomed to receive at his hands.'

The following day Lord Cowdray wrote to the Prime Minister protesting

at the impropriety of Lord Northcliffe's letter to *The Times* as 'the first intimation that you desire a change at the Air Ministry, and I think it consequent you cannot be surprised to receive my resignation'. With quiet dignity he let it be publicly known that within four weeks of his appointment in January, despite foreseen difficulty of reconciling the RFC and RNAS, he had submitted a workable scheme resulting in the Air Force Bill currently being debated. 'As for the material results of the year, the devoted work of my colleagues and staff has enabled the effective Air Force to be increased three-fold.'

Again C. G. Grey shot his barb, saying: 'If we were not at war, the spectacle of a petty parliamentarian like Mr George – a mere Welsh revivalist among politicians – presuming thus to slight a great organizer and controller of men like Lord Cowdray would be comic. The enormous size of the Flying Services today bears witness to Lord Cowdray's work. Aeroplanes are more common in the sky now than are cars on the road.'

On 26 November it was announced that Lord Rothermere, youngest brother of Viscount Northcliffe, was to be President of the Air Council. Created Baron Rothermere in 1914, Harold Harmsworth was made Director-General of the Royal Army Clothing Department in Pimlico in 1916. The *Daily Express* commented: 'Lord Rothermere has a genius for business. With Lord Northcliffe the ownership of newspapers has been a magic adventure. To Lord Rothermere it has been a triumphant business career. He founds and controls newspapers as another man establishes and runs a great manufactory. He aims at producing the largest quantities of the most saleable goods.' Possibly these business-like qualities were recommendations for success as Air Minister, for he had no knowledge of aeronautical affairs.

That same month Lord Lansdowne wrote to the *Daily Telegraph* proposing the time had come for peace by negotiation. It stirred Lloyd George to immediate reply that there was 'no half-way house between defeat and victory', making it clear that he regarded Lansdowne as a public danger. It was the end of Lord Lansdowne's distinguished career in foreign affairs, for he never took prominent part in national life again.

Nevertheless a great sector of anxious wives and parents echoed his sentiments. They were appalled at what they regarded as the Armageddon, which swept away sons and husbands and even daughters. The spacious pre-war days seemed separated from their lives by a great shadow. Nothing would be the same again. All we had was a civilian army serving with none of the illusion of glory which armed the first flush of youngsters when war broke out. Few of the Old Contemptibles were left, but the new were grimly sticking it out, hoping for the chance of a 'Blighty' wound which would send them back to England, yet in their hearts feeling they might never see home again. Sir Auckland Geddes, recently Principal of a Canadian university and brother of Sir Eric Geddes famous in the railway world, had been made Director of National Service. There was little he could do, for every available man seemed to have been drafted into the

Services or munitions. Minor adjustments would be made, but now we must depend on the fully established machinery of war, which intricately covered every possible aspect of national life in its great purpose to deal death and end hostilities. The risk was that the dull daily grind, the restrictions and lack of food, would numb the war effort. Appeals to personal loyalty could do little, for all were embroiled. Yet somehow determination to hang on must be fostered. So another new department arose – the Department of Propaganda, with Lord Northcliffe at its head, and the task of using every scrap of German evidence which would suggest that the enemy was weakening.

Thus the *Daily Chronicle* at the end of November was officially inspired to state: 'There has not been in the recent fighting on the Fronts in France much sign of the revival in German aviation despite great efforts since the appointment of General von Hoeppner as Dictator of their Air Services. The chief attention was given to squadrons of chasing planes and bombarding groups. The Albatros and other types were standardized. The Gotha works at Erfurt received large orders for their three-seat double-motor bombarding planes. The best Benz and Mercedes motors were standardized. Among other types may be mentioned the light and rapid Halberstadt-Roland, the Fokker Triplane which was a rapid riser, the 1917 Rumpler with a 260 hp Mercedes which is at present the best German scouting plane, and a new "Junker" machine, with wholly metallic body which is intended to accompany the infantry advance. The two-motor bombarding planes can carry 16 cwt of bombs, and can rise to three miles in forty minutes. The 100 machines per month destroyed by the French, and those similarly disposed of by the British, are far from neutralizing the output of German factories, and the importance of Allied superiority in this essential arm of modern battle remains.'

What could not be revealed was the tremendous numerical increase in British aircraft produced during 1917. The Air Board had good cause for congratulation.

10

British production at this stage fully matched anything the Germans could do. From an average of 50 aircraft a month in the first six months of war, deliveries in 1917 would total almost 30,000. Single-seat fighter production had increased every week of the year, from 893 in the first quarter, to nearly 2,000 in the next, 3,000 in the next, and over 4,000 in the last quarter, giving a tremendous total of 10,000 of which many were being destroyed in fighting or through accidents. Two-seat construction was nearly twice as great, achieving nearly 19,000. Seaplanes, with their more localized demand, were a long way behind with 910 completed, supported by 147 new flying-boats. Only 30 twin-engined bombers had been built by Christmas, most of them in the latter part of the year. Giving scale to the unremitting endeavour in designing aircraft of better and better performance were 69 experimental machines, of which 25 were completed in

The Sopwith Camel was in tremendous production. Sqn Ldr R. M. Hill, MC, said it made 'an irresistible appeal to a certain class of pilot'; but it was necessary to make continuous small control movements to hold steady speed, and in a dive the stick was initially pushed, only to be pulled back because of nose-down instability.

the last quarter, including a major redesign of the B.R.1 Camel to take the bigger diameter B.R.2, and referenced Sopwith 7F.

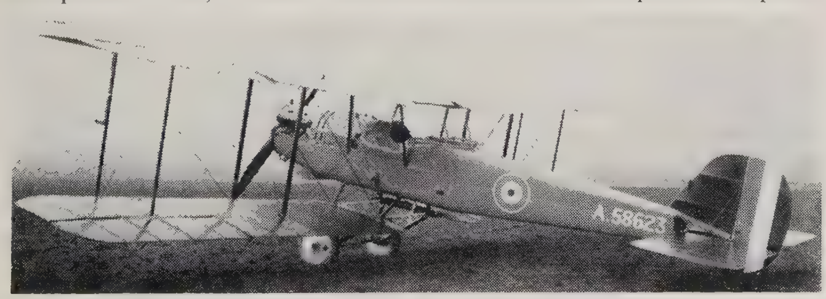
One of the great factors contributing to success was the ample freedom of opportunity given to private designers, for by this time it had been amply proved that adherence to a single school of thought was impracticable and dangerous, and that design and experiment must strive towards every possible line of new development. Even so it was considered courageous that such great advance had been made in so short a time. At the beginning of the war loadings were about 23 lb/hp and 4 lb/sq ft of lifting surface: new experimental aircraft on which hopes were now pinned had such powerful engines that they need only carry 8 to 10 lb/hp enabling wing loadings to be doubled and more. Previously it had been thought that the consequent high landing speeds would entail too great a demand on piloting ability, but it was beginning to be realized that the pilot's skill always advanced as rapidly as the demand made upon it. What was abundantly clear was that the rate of progress was wholly controlled by the skill of engine designers in providing more and more power for less and less comparative weight. Only then could a designer produce an aeroplane which achieved more than his previous one. Even so, there were inexplicable aerodynamic inter-effects which might prevent attainment of calculated performance, and this had for some time convinced Ministry technicians of the necessity of allowing several designers to offer independent solutions for each new specification and operational requirement.

The Germans had shown by their adoption of the unconventional Junkers-Fokker armoured reconnaissance biplane that they were being driven to use more complex structures and such daring materials as

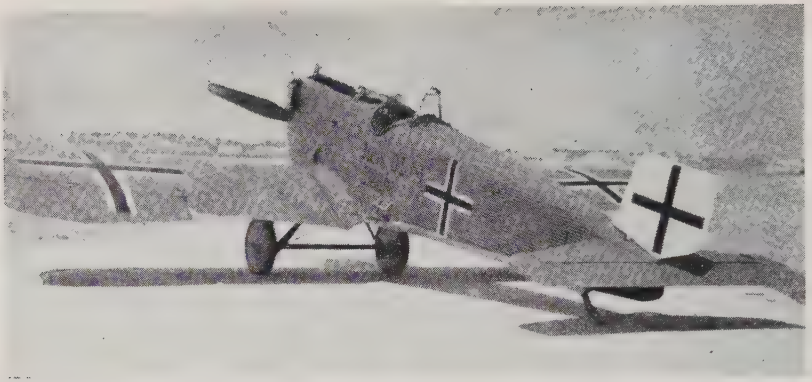
The Junkers JI/J4, often referred to as the Junkers-Fokker, revealed how far ahead was German metal design. Powered by a 200 hp Benz this 52½ ft span armoured trench fighter had a speed of 97 mph. Power loading was 23·6 lb/hp, and wing loading 8·9 lb/sq ft, so climb was slow, taking 32 minutes to attain 6,500 ft. (*A. Imrie.*)

duralumin because they were already encountering difficulty in securing suitable timber for the more rapidly producible, conventional wooden aeroplane. In Britain similar, though less urgent, contingency was in mind; but there seemed every prospect of renewed timber supplies for in Canada and the USA there were still vast forests of untapped spruce and pine, however great Dominion and American demands might be. Already the United States Government had taken drastic steps, recruiting an army of forestry workers within their Forces, who under unified command were felling vast numbers of suitable trees not only for the numerically huge aircraft production they envisaged but also to send to Great Britain and France, confident that the U-boat menace had been largely overcome using convoys guarded by armed patrol ships and under airship surveillance in coastal waters.

First sign of reviving British interest in metal construction had been Frank Barnwell's preliminary proposal in July 1916 for a metal-structured equivalent of his Bristol Fighter. Known as the M.R.1, the initial sketches were carried to practical fulfilment by a newcomer to Barnwell's staff, W. T. Reid, in whose name, coupled with that of the British and Colonial Aeroplane Co Ltd, the new form of construction received patent acceptance



Although first flown with wooden wings, the prototype Bristol M.R.1 seen here at Filton had Steel Wing Company mainplanes and was ultimately statically strength tested at Farnborough. (*Bristol Aeroplane Co.*)



The uneasy partnership of Fokker and Junkers led to construction of the radically advanced DI/J9 single-seat fighter powered by a 185 hp B.M.W. of which 41 were ordered, and a few reached the Western Front at the end of the war. (*A. Imrie.*)

on 22 August, 1917. It showed a fuselage composed of a series of interconnected trough-shaped units, having a longitudinally corrugated inner sheet-metal skin attached to a smooth outer metal skin using suitable stiffening frames. Concurrently Dr Hugo Junkers in Germany had patented construction of a single-seat fighter using sheet skinning which had external longitudinal corrugations, whether applied to wings or to fuselage. Barnwell and Reid restricted their stressed-skin construction to a fuselage which avoided double curvature, and used conventional wood-structured fabric-covered wings for the prototype. Another set of wings with tubular steel spars and lattice steel ribs was built for it by the recently formed Steel Wing Company of Cheltenham who were exploiting contemporary patents of D. J. Mooney and his partner E. E. Brown – as well as earlier ones of James J. Mayrow, who in 1916 patented a metal wing spar, derived from his 1912 patent, embracing substantially **I**-section spars with flanges connected by webs having transverse corrugations or flutings. Both the Mayrow spar and the Mooney type with bent triangular flanges were contemplated for the M.R.1 and submitted to structural tests which led to further refinements. Meanwhile the simpler wooden wing fulfilled its purpose, and the final form of the aeroplane resulted in a handsome machine with relatively slender fuselage having wings of 3 ft greater span than the F.2B Fighter. Performance with 150 hp Hispano-Suiza was as good, but complexity and cost made it inexpedient to put the machine into production. Instead, every effort must be expended in producing the Fighter and developing it with other engines, particularly as the USA hoped to adopt it in addition to the D.H.4.

To co-ordinate metal structural research, Capt A. P. Thurston was put in charge of a special department at the Directorate of Aeronautical Supply. He had gained very early pre-war experience of metal construction with Maxim, designing a Vickers duralumin spar for his mentor's second steel-framed aeroplane.

The Air Ministry was convinced that even if spruce supplies sufficed, aided by the recent innovations of satisfactory beam splicing and building spars from spirally wound wood, metal offered greater consistency in construction, and it was hoped would be safer in a crash as it would bend where wood might splinter dangerously. Typical British compromise guided the path to steel spar construction with discovery that the drawn steel sections of motor-car wheel rims were about the right size for the flanges of a suitable **I**-section beam, giving the advantage that machinery was readily available in the factories of the British automobile industry. Lieut-Cdr H. N. Wylie, RNAS, the leading experimenter with this method, was given the task of designing equivalent metal wings for the Avro 504, successfully using the facilities of the Rudge company of Coventry for this purpose – though as a serving officer he was not permitted to patent his ideas for the time being. The Dunlop company also entered this field, using similar wheel-sections, but spot-welded the web instead of riveting, and though it was difficult to control the process it had the advantage that tensile stress along the seam was much less than along the line of rivets of the Rudge spar. Soon Humber Ltd came into the picture and, under the direction of Colonel J. A. Cole and a Mr Nibblet built experimental spars from readily available metal sheet which such firms as Sankeys and Firths could supply in lengths up to 10 ft. A drawback to all designs was difficulty in applying them to existing machines without redesigning their standard fittings, but presently Humbers overcame this with a very simple spar of 26-gauge 35-ton steel, locally bridged with aluminium boxes and distance pieces, using standard Avro interplane strut fittings raised above the spar by a steel packing with strut thrust taken on an aluminium pillar within the spar, held in place by a transverse bolt passing through the webs and steel stiffening crosses and anchoring standard internal drag-wire lugs.

As an alternative to steel spars, Vickers, encouraged by their successful design of airship girders, allocated a team consisting of Commander Craven and Messrs Pratt and Temple to develop a satisfactory spar in their favourite material of duralumin. Nor was metal strut design overlooked, for it was being investigated both by Wylie, Sankey Ltd, and C. A. Llewelyn Roberts of the Birmingham Guild with a view to making a simple folded or drawn structure which would be 50 per cent lighter than conventional hollow wood struts and certainly better than round steel tube with wood and fabric fairings. A stress-bearing central member and nose was envisaged, to which a light alloy streamlined tail was added.

11

Early in December aircraft production almost came to a halt. The Secretary of the London District Aircraft Woodworkers Council issued a manifesto stating that at the instigation of the Ministry of Munitions a ballot vote had been taken on the acceptability of a system of payment by results, but an overwhelming majority of woodworkers decided against it.

Contracts for obsolete machines, inefficient inspectors, shortage of materials and woodworking machinery, together with the time-honoured excuse of bad management, were blamed for slack production.

At a meeting at Caxton Hall convened for discussion between union officials and employers, the men were kept waiting an hour and then handed a statement that employees agreed to a standard minimum pay related to the cost of living, provided the unions agreed to payment by results. At this all union members ceased work, determined not to resume until settlement was reached.

Strikes spread to the aero-engine makers of Coventry, starting at the factory of White and Poppe whose manager tactlessly said: 'In Coventry the Employers' Federation does not deal with shop stewards. I am always prepared to see deputations of my men on small matters, or to deal with unions on important affairs. We employ 6,000 women here. They have been splendid. We have been able to keep half of them at work during the day.' But the secretary of the Coventry Engineering Joint Committee baldly stated that the men would stay out till they got what they wanted. They picketed every factory so that not even clerical staffs could enter, and the Daimler, Humber, and Swift companies issued notices regretting the impossibility of making out pay-sheets for their men under the circumstances.

Sir William Weir, Controller of Aircraft Supplies, said: 'I regard this stoppage as very grave in its results. For months the nation has been calling for an invincible Air Service. To provide it quickly requires immense effort, analogous to that initiated by the Prime Minister when he started the Ministry of Munitions. The time is even more precious now than it was then, for the problem of increasing aeronautical supplies is much more complex than the Ministry had to face two years ago, and a stoppage of work in any one of the many industries involved is sufficient to retard the whole of our constructional programme.'

In the *Morning Post*, Massac Buist, well-known aeronautical journalist, slashed out the warning: 'The trouble is made almost entirely by the younger men who if they were not at present being protected, would be in the trenches. Of course a deal of trouble is due to ridiculous tales touching alleged profiteering. It may have occurred in certain industries, but not by manufacturers in this country supplying the requisites for war. The reason is obvious. Government accountants have in every case taken records of actual costs of production. A fixed ratio of profit is allowed on those proved costs. Further, there comes automatically into play the Excess Profits Duty. To earn a sovereign profit today requires not only more capital, but involves vastly greater risk by capitalist and employer than in peace-time. If these facts, and individual examples, were cited by the Government, labour might realise that further agitation on its part is in itself deliberate profiteering and tyranny.'

The great South African Boer leader, Lieut-Gen J. C. Smuts, was deputed by Lloyd George to meet representatives of the employers and employees and only by exercise of his great tact was reconciliation effected.

A sign that internal matters in aviation companies were not always as satisfactory as they seemed was indicated by an announcement in the *London Gazette* that Mr Humphrey V. Roe, the business brain behind A. V. Roe Ltd, had been commissioned Lieutenant on the General List RFC. He veiled what differences there were by saying that the company had for some time been established on an organized commercial basis, and could go on running in the same way without him at any rate for the duration of the war; as an old soldier he had therefore applied for the honour of wearing the King's uniform. Said one of Alliott Roe's colleagues of that time: 'Dear old A.V. had been always liable to keep changing his mind on detail design work, though with good intention, but it seriously delayed issue of drawings. Notes in my D.O. Time Book point to many changes he requested me to make as far back as the Type 529 interplane strut wing fittings. Unfortunately this Time Book provided evidence at a Board meeting which I think started the rift between him and his brother H.V.' In fact at this point A.V. was more interested in the mechanical development of items such as bomb gears and gun mountings than aeroplanes, except for his beloved 504.

A Handley Page O/100 piloted by Sqn Cdr K. S. Savory was flown to the Aegean, and in July 1917 bombed Constantinople, but was later captured because of engine failure while piloted by Flt Lieut Jack Alcock. A year later the O/400 illustrated was flown to Palestine for local raids and was also used by Col T. E. Lawrence.

By contrast, Handley Page proudly advertised that one of the O/100s had carried out a successful air attack on objectives in the vicinity of Constantinople, and to do so had flown from England nearly 2,000 miles in just over 31 hours – a world's record for a cross-country journey. The feat appealed to the public's imagination. If it was child's play to a great machine like this how easily could a great fleet of them pound Berlin into dust; but they were quite unaware how few of these bombers had been completed.

The end of the year at least foreshadowed hope. Through the war news ran a fresh thread of interest, for General Allenby, on taking command in Egypt, had transformed the situation from defence of the Suez Canal to a great attack on the Turks, and was now moving across the desert in

Palestine. Biblical names attained new interest as the tide of war swiftly swept through what was still regarded as the Holy Land. There was an anxious pause as Jerusalem was approached; many were horrified that it would be pounded by great guns and trampled by tanks. News that it was not harmed was like a sigh of relief; yet it was the religious feeling of the Turks that saved Jerusalem, for they surrendered it to Allenby.

The Germans might be planning a great final assault to sweep away the Allies before the massed forces of the Americans reached the Western Front, but here on the Eastern fighting line success had come at last and might augur well for the future everywhere. It was short-lived. On 22 December, Peace negotiations between Russia and Germany started. Soon German troops would be pouring back from these other fronts to strengthen their great attack in the West.

CHAPTER VII

THE SWEEPING TIDE

1918

'Now, knowing the conditions an aviation apparatus must fulfil, realizing the difficulties that are encountered in seeking to evolve, raise, and control it, and instructed in its handling, we shall be better able to appreciate the immense effort put forth by those who were creators of heavier-than-air aerial locomotion.'

Alphonse Berget (1909)

1

FIVE THOUSAND aircraft inventions submitted in the last nine months had so overwhelmed the Air Inventions Committee of eminent scientists under the chairmanship of Sir Horace Darwin, that a cautionary statement was issued to the Press at the beginning of January: 'It is appreciated that in present circumstances inventors are placed at great disadvantage, because unless they are immediately connected with the Air Services or with aircraft manufacture it is almost impossible for them to be acquainted with the most recent developments, so rapid has progress been.

'A stage has been reached when major improvements can be expected only from those possessing the requisite scientific and mechanical knowledge, skill, and experience. Thus radical changes in the wings, body, or airscrews are possible only after long and patient research in aeronautical laboratories. Schemes for helicopters (an efficient design for which would possess certain advantages, though probably not so great as was once imagined), and for flapping wings and rotatory planes do not give any promise of being developed during the war, and would require some years of experiment before they could be regarded as practical proposals. Inventions such as the internal combustion turbine, differing radically from present practice, have small possibilities of adoption, because successive design and reconstruction would probably entail several years' work.'

Not inventions but food was the necessity, although it was clear that the submarine menace was being held at bay, and new ships launched so extensively that losses were being overtaken, there was sudden deterioration in the food situation partly because it was winter but largely through

earlier impact of submarine warfare on imports. Although everyone was registered with grocer and butcher, straggling queues for butter, margarine and tea became a feature of every town, and butchers' shops often remained closed for lack of supplies. The Ministry of Food wasted no further time: rationing cards were issued allowing registered customers no more than $\frac{1}{4}$ lb of butter a week, $1\frac{1}{2}$ oz of tea, and $\frac{1}{2}$ lb of sugar. Meals became stringently regulated at restaurants, and as there was no sugar, customers began to bring little phials of saccharin tablets for their watery tea.

The populace metaphorically tightened its belts with the catch phrase 'grin and bear it'. Despite unrest over pay and alleged profiteering, the masses were prepared to see things out, however grim the coming months. Even so about 10,000 employees of the Austin Motor company struck work, dissatisfied with their bonus payment scheme and irritated by exclusion as aircraft workers from a $12\frac{1}{2}$ per cent pay increase given to other munition operatives.

The particular skills of aircraft construction were still not fully comprehended by hundreds of sub-contractors. Many efforts were made to extend knowledge of materials and jigging and tooling, the Aeronautical Society playing a valuable educational part. Prominent members participated in practical discussion on manufacturing problems. Thus Lieut-Col H. W. S. Outram, AID chief inspector of aeroplanes, discussing jigging, said that the more used the easier his task, but it was extraordinary how jigs made for the same job in different works differed from one another – a matter fatal to component interchangeability required for operational conditions. Hiscocks of Airco argued that the amount of jigging depended on when one got the drawings and the number of modifications required, but particularly on the time available between issue of drawings and the scheduled delivery of aircraft. With this Handley Page concurred, saying that the question of jigs and tools depended on the extent of the production order – a matter in which, in his opinion, the Services needed a little education, for unity of production was no good without unity of demand. Most of the audience, as hard-headed general engineers, thought the AID too exacting. 'If the AID used a little more practical knowledge they would expedite output to a considerable extent,' said one. This produced an outburst of applause which at least made it clear that there was a big bridge to gap between what seemed practicable and the accuracy demanded of aircraft work.

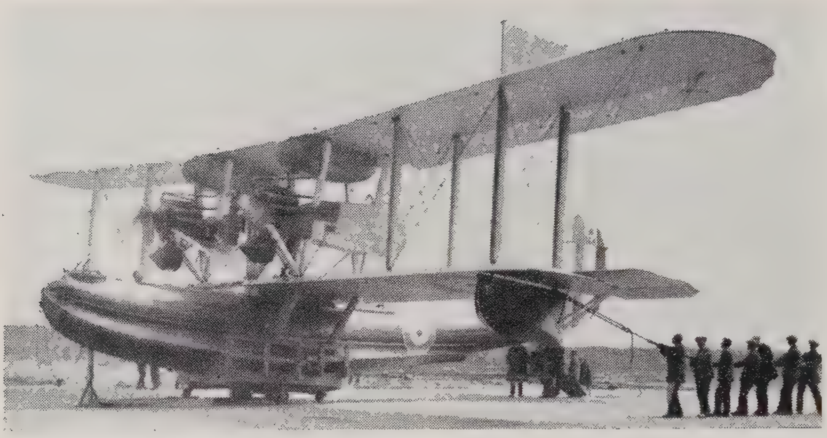
Nor was it easy to secure unanimity of opinion even within an aircraft works. There was usually a tussle between works management and designers, for the latter were considered difficult people on the whole. In design offices there were rivalries exacerbated by ambition or sense of injustice arising from disparities in knowledge and experience. Thus at Sopwith there had been uneasiness throughout the past twelve months, and with the new year it came to a head. Herbert Smith was strongly backed by Sopwith and Sigrist, for he was a go-getter and therefore tended

to irritate others equally devoted to their tasks. Ashfield could stand it no longer, for Carter had taken over much of his design responsibility, so he quietly resigned, and in January joined a comparative newcomer to aviation, Gosport Aircraft Co Ltd, which had been formed by Sir Charles C. Allom, a well-known yachtsman. With him in the new business was Charles Nicholson, designer and senior partner of Camper and Nicholson, world famed yacht builders. Their yacht yard had been reorganized for aircraft by M. H. Volk, that pre-war founder of a seaplane station at Brighton who subsequently became Gordon England's assistant in establishing the aircraft department of Frederick Sage at Peterborough.

Herbert Smith (left), the hard driving war-time chief designer of Sopwith, had pre-war aircraft experience as a draughtsman at Bristol's, but R. J. Ashfield (right) started even earlier as the first draughtsman of Sopwith's designs and was responsible for many subsequent Sopwith successes.

Henceforth Ashfield held subordinate responsibility to Percy Beadle, who with the late Copland Perry had made the pre-war Perry-Beadle sponson-wing flying-boat, and latterly was chief designer of Norman Thompson Flight Co Ltd, at Bognor Regis. Beadle's work had culminated in the very advanced little two-seat N.1B single-engined flying-boat, but ended in a showdown towards the end of 1917 because the RNAS at Grain found its performance far less than estimated. He now commenced an ambitious design programme at Gosport with a range of flying-boats from single-seaters to long-range multi-engined spotters using boat-built hulls more akin to Porte's designs than the rounded flexible hull devised by Linton Hope which was featured for a large hull, 45 ft long, being built by May, Harden and May for an airframe designed by W. O. Manning at the Phoenix Dynamo Manufacturing Co as a rival to the F.5 flying-boat.

The work of the Royal Navy and its seaborne air service was shadowy, yet on far vaster front than the armies fighting in France whose every move was eagerly noted in the Press. Day in and day out, high-speed motor-boats, steam tugs, and trawlers, were steadily carrying out their unsung and dangerous task of sweeping our sea approaches clear of mines; while



The Phoenix P.5 Cork had a beautiful varnished Linton Hope hull, though wings and tail surfaces with their fluted trailing edges had a somewhat old-fashioned appearance. The photograph shows the later derivative powered with Napier Lions and accommodating a gunner in each nacelle.

ships with hydrophones, and patrols of seaplanes, flying-boats, and airships spotted off-shore for submarines, ready to sink them with effective depth charges.

Yet clear winter moonlight nights continued to give the German Air Force broad scope in harassing the civil population. Raids had become even more terrifying than of old. At each noisy warning from detonating maroons used in preference to factory sirens, there would be nerve-racking uproar for an hour or two from anti-aircraft batteries and the splintering crash of bombs. Most people stuck it, confident that the increased din at least meant Britain was putting up defence at last. Taken as a whole, despite the disruption of wild-cat strikes, the people stood united; for war was impersonally affecting everyone, inevitably changing class consciousness even though the office boss was still deferentially addressed as Sir.

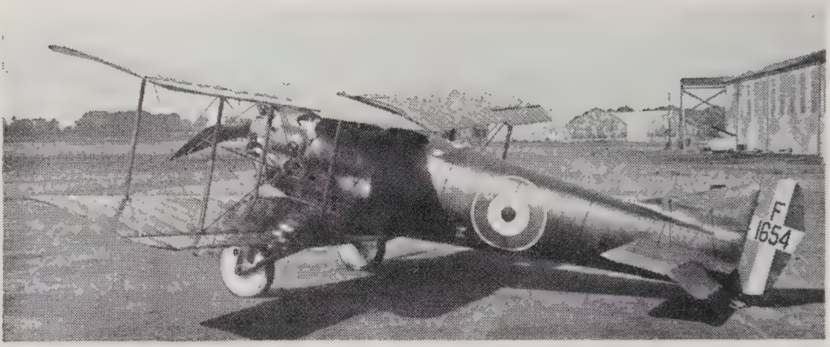
The Labour Party itself had assumed a new look. Previously membership comprised groups of trade unions and societies: now it was open to individuals whether they worked in a factory or not. Hitherto it had been the instrument of industrial areas: henceforth it could rank as a national party competing in policy against the long-reigning Liberals and Conservatives. Yet in February Henderson had to warn Parliament: 'At no time during the war has the industrial situation been so bad,' for factory workers would form cliques and factions repudiating the leadership of their unions. Perhaps too much attention was paid to Labour by the Press, making it seem to sail under the flag of malcontents while the rest of the country were gamely flying the national ensign.

Yet there was no real check of forward progress. 'One of the most striking features of the aircraft industry's progress in 1917,' wrote C. G.

Sqn Ldr Roderic Hill, later star Farnborough pilot, commented that the Avro 504J training biplane could be loaded up in the most extraordinary way and yet be comfortable to fly. It had a lucky but ideal correlation between stability and controllability. (*A. R. Boeree.*)

Grey, 'was the continued pre-eminence of the pioneers in designing new types. The enemy knows to his cost that the best machines have been those of the earliest designers. The Sopwith Pups and Camels, the de Havilland reconnaissance machines, the Martinsyde Elephants, the Barnwell Bristol Fighters, and the S.E.s, which still show traces of early de Havilland influence, are products of men who went through the mill in the lean days before the war. In the training division the Avro is pre-eminent. The Armstrong Whitworth, designed by Mr Koolhoven, holds its place, and one gathers that Mr Koolhoven's name is likely to be considerably more prominent in future. The Short seaplanes, the Fairey seaplanes, the Porte flying-boats, have all been designed by pioneers. Taking it all round, the Services in the air, afloat, and on land owe a debt of gratitude to those who by sheer pluck survived pre-war neglect.'

His reference to Koolhoven seemed justified. All who saw his B.A.T. F.K.22 realized that here was a unique aeroplane, representing a breakaway from traditional fighter design and affording astonishingly low structural weight. Its intended Mosquito engine had revealed so many snags that Granville Bradshaw abandoned it in favour of his 170 hp Wasp, which he was developing in step with the much more important 320 hp Dragonfly. Indeed the A.B.C. Company, which Weir in his ignorance of all implications had gambled on being the most important of all engine producers for a broad range of future aircraft, had taken too big a step in promising early perfection of their air-cooled radials. Koolhoven, the ardent salesman, was quite undismayed. His fascinating little fighter was quickly converted to take a spare 100 hp Gnome Monosoupape. Named Bantam Mark II, it was flight-tested by Peter Legh and, with no modification, sent to Martlesham for official handling trials at the beginning of the



The B.A.T. F.K.23 Bantam originally had only 20 ft span, but in production form had 25 ft wings, steel-tube interplane struts, and modified tail. It is shown at Martlesham where a speed of 128 mph at 6,500 ft was recorded, but the engine remained too capricious for production. (*A. R. Boeree.*)

year. By then Noorduyn had redesigned it as the F.K.23 in still more diminutive form for the Wasp. Loaded at 700 lb less than production Snipes, it needed only a light-weight engine, but despite tremendous efforts at convincing Colonel Ogilvie's technicians of this advantage coupled with brilliant handling qualities, the Bantam's unconventional construction, difficulty with the Wasp, and some lack of faith in Koolhoven, prevented a production order. It was finally damned on discovering that it had disastrous spinning characteristics.

Koolhoven was not alone in producing a monocoque-type fuselage. Herbert Smith's team at Sopwith emulated with design of the 8F.1, nick-named the Snail* because construction was delayed due to the urgency of

* Named under new system of nomenclature see Appendix V.

The Sopwith 8F.1 Snail, seen at Martlesham, was practically the same size as the B.A.T. Bantam, and similarly disqualified by its A.B.C. Wasp engine, but nevertheless was regarded with favour by pilots as being a handy little fighter of very up-to-date design. (*A. R. Boeree.*)

Front view of the Sopwith Snail, showing its small size. (*A. R. Boeree.*)

modifying the Camel to 230 hp Bentley 7F.1 configuration – and then by considering how armour could be incorporated for ground attack straffing of trenches and troops, following a lead set by newly promoted Colonel Bishop who had gained a VC in August as a result of such an exploit with his bullet-scarred Nieuport.

On return from his Canadian visit Bishop found himself 'in the doghouse', as he described it, because of his fervent speech on the shortcomings of American aircraft production. The Government was horrified that the Germans had gained substantial confirmation of American unpreparedness for war. With the enemy about to make the culminating effort to smash the Allies on the Western Front, it was criminal folly to have advertised our rich supporter's weakness. Billy Bishop, a national figure to whom the King had presented the VC, the DSO, and the MC at the same investiture, was interviewed by the gruff but discriminating Trenchard and quietly posted as chief instructor to an aerial gunnery school until the storm blew over – though it was pretty clear that the Americans would now have to put their house in order.

In the New Year's Honours List Maj-Gen Trenchard, G.O.C. of the RFC in the Field, was appointed Knight Commander of the Bath. It was rumoured that he was relinquishing his appointment and that Maj-Gen John Salmond would succeed him as Commander of the RFC.

2

Since introduction of the Air Force Bill, Pemberton Billing had needled the House on more than a hundred occasions by proposing amendments which invariably were defeated. But on 2 January there were signs that things were moving, for an Order in Council established an Air Council comprising Lord Rothermere, Secretary of State and President of the Council; Major-General Sir Hugh Trenchard, KCB, DSO, Chief of Air Staff; Rear-Admiral Mark Kerr, CB, RN, Deputy Chief of Air Staff; Commodore Godfrey Paine, CB, MVO, RN, Master-General of Personnel; Major-General W. S. Brancker, Comptroller General of Equipment; Sir William Weir,

Director-General of Aircraft Production in the Ministry of Munitions; Sir John Hunter, Administrator of Works and Buildings; Major J. L. Baird, CMG, DSO, MP, Parliamentary Under-Secretary of State; Lieut-General Sir David Henderson, KCB, DSO, Additional Member of Council and Vice-President; W. A. Robinson, CB, Secretary to the Council; H. W. McAnally, Assistant Secretary.

Under Sir William Weir the Aircraft Production section had Henry Fowler as Assistant Director, although he temporarily retained appointment as Superintendent of the Royal Aircraft Factory; Lieut-Col W. Alexander was made Controller of the Supply Department; Lieut-Col J. G. Weir, younger brother of Sir William, became Controller of the Technical Department; and Sir Arthur Roberts was appointed Financial Adviser in co-operation with Bertram Jones, a well-known City financier whose business was now to promote economy.

To set the stage General Henderson had prepared a secret report for the Cabinet, surveying aircraft supply throughout 1917, but extracts were released to United States officials to warn of difficulties they might encounter. 'In endeavouring to describe the measures taken to meet the aircraft needs of the Navy and the Army,' warned the report, 'the writer is at once confronted by the fact that information desired by the country is precisely the information desired by the enemy.' Re-reading in modern context reveals Henderson's thorough grasp of every aspect of aircraft and engine development and the interrelation with provisioning policy and Service operational use.

'Experience shows that from the date of conception and design of an aero-engine to delivery of the first in series, more than a year elapses: the corresponding period for an aeroplane is about half as long. The hopes based upon promising results given by the first experimental engines of new design are frequently disappointed owing to difficulties of bulk manufacture, or to defects only developed after long trial in the air; new types of aeroplanes favourably reported on when first tried are found on longer experience not to give complete satisfaction; and yet it is impossible, if we are to keep ahead in the keen struggle for aerial superiority, to wait for full experience before placing orders. Risks must be run.

'The next problem is balancing the engine and aeroplane programmes. Orders for the former must be placed relatively long ahead, before it is known what types of aeroplanes will be required when the engines become available. The problem is complicated by the fact that manufacture and delivery rarely, if ever, proceed in accordance with anticipation, and may be delayed for months owing to some technical difficulty of manufacture. Moreover, as expansion and replacement of losses are proceeding simultaneously in the Flying Services, and the rate of wastage in different types of engines and aeroplanes varies considerably with circumstance, it is impossible to forecast accurately what engine will be available for the equipment of new types of aeroplanes after wastage has been made good.'

Henderson's unadorned comments on the engine situation were early

warning of near disaster that could only be saved by speeding production of Bentley's high-powered rotary engine, the B.R.2 – for the Dragonfly, on which such great hopes had been pinned, was proving a disastrous failure, and even the little Wasp could rarely be made to run more than two hours before stripping down. For the 1919 offensive, all the new highly manoeuvrable, swift-climbing single-seat and two-seat fighters, as well as some of the twin-engined bombers, depended wholly on the light-weight, high-powered but refractory Dragonfly for which Vickers was now handling development at Maxim's old factory, the Crayford works. Everyone had been convinced that it was the engine which could win the war, for its weight of 600 lb was much the same as the B.R.2 yet it was rated at 50 per cent more power. That was the great attraction – but the engine had a fundamental hidden fault. Other than by practical trial, little was known of the dynamics of balance and vibration. When the prototype was bench-tested there were mysterious failures due to the unknown phenomenon of synchronous torsional vibration. Within an hour or two, sometimes only minutes, there would be such bad running that the engine had to be stopped. Yet everybody still hopefully assumed that the defects were only teething troubles, and would soon be overcome.

Instructions were now issued for immediate revision of new aircraft, as far as possible, to take the lower-powered B.R.2; but throwing away 100 hp might well prove disastrous in competing with new German aeroplanes of greatly increased climbing capacity and ultimate ceiling, for the lesson all fighting pilots had learned was that climb and height were paramount, coupled with strength and manoeuvrability in a terminal nose dive when pouncing on an enemy.

The metamorphosis of Sopwith Camel into 7F.1 Snipe revealed a prototype with transparent centre-section for fighting view and single-bay wings of 2 ft 3 in less span having matched dihedral and 6 in greater chord to give identical area. A 150 hp B.R.1 engine was initially fitted. Armament was identical with the Camel. (*Fleet Air Arm Museum*)

The second Sopwith Snipe prototype was similar, but had an early Dolphin-type fin with balanced rudder, and the flat-sided fuselage structure was rounded at sides and top with stringers to give better aerodynamic form. The centre-section was wider and centrally notched to give good view. (*G. Quick*.)

It was at this point that the prototype single-bay 7F.1 Snipe development of the Camel had its engine changed from the temporary B.R.1, fitted for initial handling trials, to the B.R.2, which despite greatly increased power was only 93 lb heavier. Maj-Gen Brancker was particularly keen in pushing this engine, though it had been received cautiously by 'the experts', who considered that so powerful a rotating mass would disintegrate under the big centrifugal loads, and in any case torque would be too great to be corrected if the lower-powered Camel was any guide, for it seemed already on the limit.

The experts seemed proved correct when the new Sopwith prototype was flight-tested. Virtually a Camel with small-span wings of which both

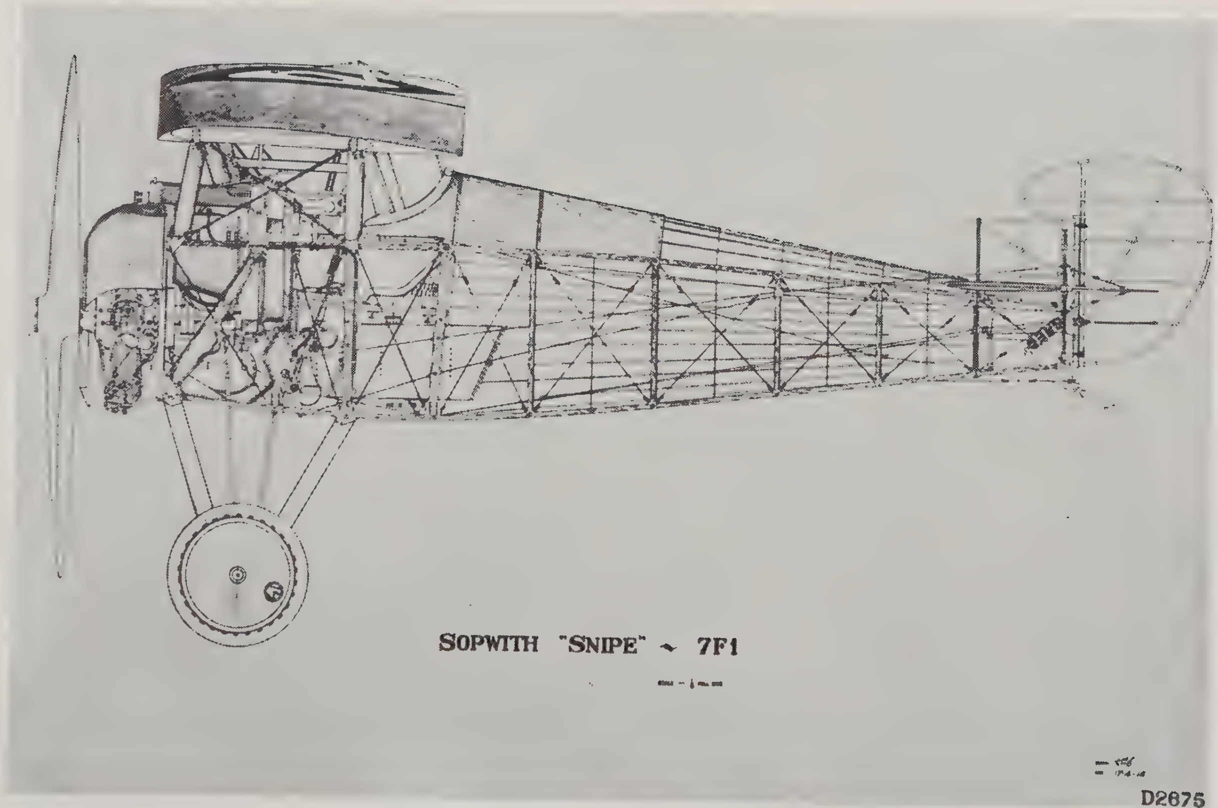
During investigations of wing vibration an experimental Sopwith Camel was fitted with mid-bay flying wires in similar manner to Farnborough designs, but they were not standardized. (*Imperial War Museum*.)

had dihedral, it revealed not only that wing dropping due to torque was almost impossible to rig out by differential twist, but the top wing suffered such abnormal vibration that the centre-section struts of the second prototype, which had a circular faired fuselage with flat bottom, had to be splayed farther out to alter the period by shortening and thus stiffening the top spars. Vibration of this nature was already familiar to the Sopwith designers, for the lower planes of the 1½-Strutter vibrated considerably at high engine speed, and extensive investigation had been conducted by Lieut A. H. Stuart, RNVR, lest such vibrations might prove fatal in the faster and yet faster dives imposed on every type of fighting aeroplane. He reached the broad conclusion that interplane struts should not be located 'more remote from the free end than 30·5 per cent of the whole length of the spar'. It was to avoid somewhat similar trouble that the B.E.2e, R.E.8, and S.E.5 series had been fitted with short subsidiary flying wires attached about one-third outboard of the centre-section struts.

The final production version of the Sopwith Snipe had horn balance to the top ailerons and a larger fin with shielded horn balance for the rudder which was of increased area. This Boulton and Paul built Snipe was fitted with a non-standard centre-section mounting for a Lewis gun. (*A. R. Boeree.*)

Though splaying the Snipe's centre-section struts markedly reduced vibration there remained the problem of torque reaction and necessity of improving lateral control, both of which could be ameliorated with greater span while gaining the dividend of improved climb. Herbert Smith therefore had a new wing structure designed with span increased by 4 ft 3 in, and to reduce the spar bending moments used a conventional two-bay structure. In this form the third prototype appeared at Brooklands in January for comparative handling trials by Harry Hawker, and finding that it performed sweetly, lacking the viciousness of the Camel yet smoothly manoeuvrable, it was flown a few days later to Martlesham for official assessment.

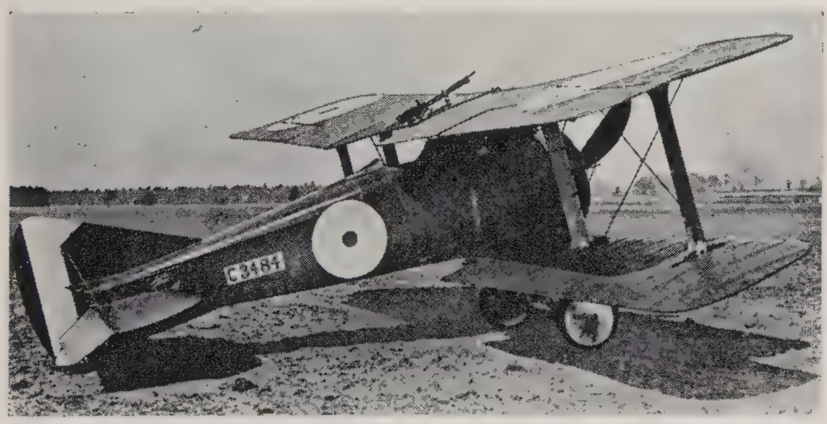
It was some months ahead of its potential rivals, the B & P Bobolink,



Original Sopwith drawing of two-bay third prototype Snipe. (*Fleet Air Arm Museum.*)

Sopwith 7F.1 Snipe built by Boulton and Paul. (*Imperial War Museum.*)

Austin A.F.T.3, and British Nieuport B.N.1. Well before they arrived at Martlesham the Snipe completed trials in February, and although Report M. 176A revealed disappointing speed compared with the Camel, Dolphin, and S.E.5a, the climb was regarded as magnificent, and the long-span wings gave confident control in the rarefied air at ceiling compared with the dull response of the S.E.5 and the dangerous flick into a spin of the Camel. Although the rudder was bigger than the Camel rudder originally fitted, directional control was still criticized as weak, for the Sopwith team was misled by the stabilizing effect of the unshielded horn balance which had been fitted in conjunction with a shallow Dolphin-type fin. Noticeable



Hallmarked with S.E.5 influence, Henry Folland's attractive but daring I-strutted British Nieuport B.N.1 was his first industrial design but eliminated by decision to standardize the Snipe as the 1919 Fighter.

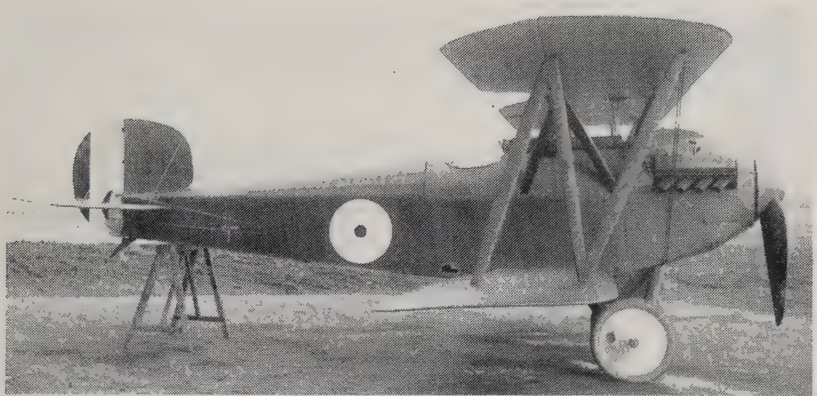
nose-heaviness in turns was overcome by slightly rigging *back* the top wing and altering the tail incidence. Whatever the residue of small faults, the Snipe's standardization of fittings and components already in production for the Camel made it an obvious successor, however good its rivals, for quick production was paramount. Orders were substantiated for more than 1,800 Snipes from Sopwith aided by five other airframe contractors, including Boulton and Paul as major builders of Camels, and Coventry Ordnance where Manning, in pre-war days, had struggled to introduce aircraft design with an entrant for the 1912 Military Trials competition. The others were D. Napier & Son, because of their car body building facilities; Ruston, Proctor & Co of Lincoln; and a new and pushing business, Portholme Aerodrome Ltd of Huntingdon. An airframe production price of £945 17s was soon standardized, and it was expected to place further orders with other Camel manufacturers, but for the time being their present production remained paramount, as many regarded the Camel as the most effective fighting machine of the war.

Although the B.R.2 had been ordered in vast quantity the Air Council was fully aware that the whole history of aviation showed there was always immediate demand for still greater power for the next generation of aeroplanes, particularly for fighters; but it was clear that the rotary had attained its limit. Unfortunately it was not immediately likely that the Air Board's earlier choice of two alternative radials would soon be available. At Siddeley-Deasy, development of the Jaguar had come to a halt with the irate departure of S. D. Heron, leaving Green with no specialist on his staff competent to deal with so involved a design.

The active hope was Roy Fedden at the Brazil Straker company at Fishponds, where under his direction the fourteen-cylinder two-row radial Mercury had been draughted by L. F. G. 'Bunny' Butler, and for some time had been ready for bench tests, but work was held up while the business was re-formed with increased finance and renamed the Cosmos Engineering Co Ltd. Many years later Butler commented to Frank Nixon: 'It was a lovely engine and ran like a sewing-machine.'

Nixon recorded that: 'There could be no greater contrast than Fedden and Butler. Fedden had bulk, and commanding presence, immense dedication and drive, and a grasp of detail which made it impossible for his juniors to escape devastating criticism during long and frequent meetings. Butler was a small dapper man, with abundant nervous energy. He was an excellent designer, practically instantaneous in his grasp of a technical point, and possessing a great knowledge of manufacturing techniques and capabilities. He personally vetted every drawing before he would allow it to be issued. If he doubted the ease of manufacture of a detail he would pore over it with Whitehead and together they would thrash out a simpler design.'

Nearby at Filton Frank Barnwell had already designed a new fighter, the Scout F, which pending availability of its intended Mercury was fitted with a 200 hp Sunbeam Arab. That was another engine which was proving



The British Scout F, with Sunbeam Arab engine, gave pilots confidence as it looked very strong and handling was considered superior to the S.E.5a in some respects – but the unsatisfactory engine eliminated it, particularly as the Martinsyde F.3 was even faster. (*Bristol Aeroplane Co.*)

useless, for like the Dragonfly, it was suffering untraceable vibration. The widespread nature of engine difficulties was shown by the 1917–18 files of the Engine Sub-Committee of the Advisory Committee for Aeronautics: 'Among matters which have been before them may be mentioned the methods of engine testing, engine design for high altitudes, the causes of failure of crankshafts and other parts, gearing, methods of cooling, methods of preventing freezing at high altitudes in water-cooled engines, special fuel, and considerable attention has been given to magnetos and ignition.' Torsional vibration was exercising the brightest brains at Farnborough. An ingenious method of using soap film in solving such problems was devised by G. I. Taylor, MA, and A. A. Griffith, M Eng, based on equations propounded by Prandtl as early as 1903. The film was stretched over a special hole in the test piece and distortion measurements were used to determine the total torque and stress at any point, whatever the shape of the bar being twisted. Results agreed within one or two per cent compared with solutions by tedious and involved mathematics. With the equally youthful A. A. Griffith, Taylor had devised the first primitive form of analogue computer which they used for mathematical solutions of stress distribution in shaft key-ways, and this led to detailed investigation of inter-molecular forces and the effect of cracks. In May 1915 O'Gorman had temporarily released him to learn flying in the RFC, and after achieving his 'Wings' he returned to the Factory and devised apparatus for pressure measurements on mainplanes of an aircraft in flight, thus affording valuable co-ordination with wind-tunnel model work. Shortly after his report was published on the soap film method of stress computation he became RFC Meteorological Adviser, playing a prominent part in organizing night-bombing experimental work, elaborating a method devised by Major Bertram Hopkinson, that earlier Cambridge professor who had done so much to establish scientific flight testing.

Among others, the Bristol Scout F was the subject of Farnborough aerodynamic investigations at an early design stage. They made comparative tests of aerofoils respectively for the standard Bristol Fighter F.2B and a single-seat Scout E which became Scout F, and compared them with RAF 16 wings. Results had their usual inconclusive air: 'Scout E appears to be better for high-speed work in as much as it has a high L/D at low-lift coefficient and also higher maximum lift coefficient, hence the lower stalling speed. On the other hand F.2B has an appreciably higher value of L/D at large lift coefficient and accordingly will climb more efficiently than with Scout E sections. As far as aerodynamical properties are concerned RAF 16 is superior to Scout E at a lift coefficient of 0·1, having an L/D of 11·2 compared with 9 for Scout E, but for equal-wing areas F.2B has superiority over RAF 16 for climbing.' Probably Barnwell gave a sigh and turned to the practical consideration that in any case the rear spar of RAF 16 section was too shallow.

More conventional than the B.N.1, the Nieuport Nighthawk with a speed of 150 mph greatly appealed to pilots because of its good compromise between stability and manoeuvrability, but although a production order was given late in 1918 the refractory 320 hp Dragonfly engine would have prevented early operational use. (*G. Quick*.)

More readily assessed was the structural testing at Farnborough on a pair of two-bay **I**-strutted wings designed by Folland for his rival of the Snipe, the Nieuport B.N.1. Earlier in the war he had used a similar structure for the experimental S.E.4, but there had always been doubt of the stiffness, and when Folland redesigned this Scout as the S.E.4a he used conventional front and rear interplane struts. With his first effort as a Trade designer he had to make sure that what was virtually the latest derivative of the S.E. series would not have structural question marks. It was therefore being statically tested to determine the ultimate strength in a vertical dive.

Folland's **I**-interplane struts comprised streamlined upright spruce shafts to which horizontal walnut ends were scarfed and held by narrow aluminium plates secured by hollow rivets; the foot thus formed rested


King George V and Queen Mary paid visits to many big war-time firms, and here are shown at the Airco works accompanied by Holt Thomas (left) and Hugh Burroughes. (*F. E. N. St Barbe.*)

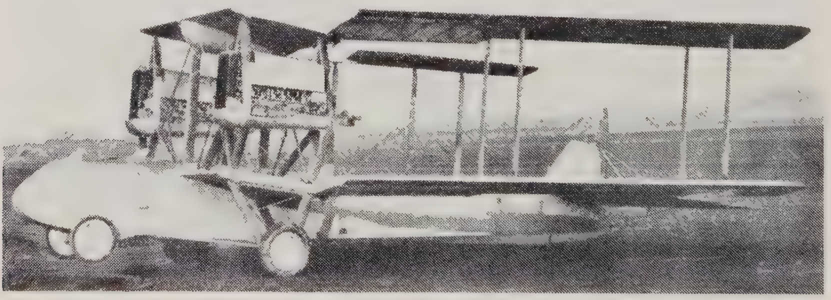
across the top of the spars and was secured by vertical bolts. The torsional couples imposed by diving were represented by artificial down-loads on the front spar and up-loads on the rear spar of increasing magnitude until compression creases formed in the leading edge of the struts at the top, and the trailing edges failed in tension. Although this did not occur until the total load on the rear spars attained 7,325 lb – which was regarded as satisfactory for the 1,950 lb all-up designed weight of the B.N.1 – it was deemed desirable to make comparative tests with a conventionally strutted machine of similar size. This left doubt in Folland's mind, so the preliminary lay-out of his next fighter design, intended for the eagerly awaited 320 hp A.B.C. Dragonfly, showed conventionally strutted two-bay wings of the form currently proved so effective with the Snipe.

3

The first month of every new year was occasion for George Holt Thomas to take stock of the general position, perhaps because it was associated with pay increases! Once again he wrote from his head office at 47 Victoria Street to the man who over and over again had proved of outstanding worth. 'Dear de Havilland,' he dictated. 'I am so very fully occupied that I very rarely have an opportunity of seeing you now. With reference our conversation on the question of a longer Agreement I write to say that I shall be willing to come to an arrangement with you by which the terms of our Agreement are generally left intact, but the Agreement will now be that you continue in your present capacity for a period of

five years.' He was shrewd enough to add that in the case of machines built at factories other than Airco no royalty would be payable. To encourage de H. he mentioned the proposed D.H.7 single-seat fighter, and the possibility of D.H.4 sales to the Bolshevik Government as 'I am of course always negotiating for foreign and Colonial business'.

But de Havilland was not the man to set any great importance on personal material gain. Neither politics nor big business were for him. Though he was reticent, and therefore relatively little known, he possessed that unselfconscious quality of unifying his staff into a team of unswerving loyalty. By now it was reaching towards a hundred men and women, and, as the established design leader, 30-year-old Arthur Hagg was cutting something of a figure with his smart suits, spats, bow tie, and smoothly swept-back dark hair above a high forehead. The cares of finance were being dextrously handled by Hugh Burroughes, ably assisted by Wilfred E. Nixon, who had originally been a clerk on his accountancy staff at the Royal Aircraft Factory. Significantly Burroughes commented: 'Up to the middle of the 1914–18 War Holt Thomas was a vigorous and imaginative individual, and shrewd businessman, and a pretty good administrator, but he had always had a weakness in his throat, and somewhere about this time it seemed to get worse and to impair his judgment.'



The prototype D.H.3 had folding wings and was a few feet smaller than the D.H.10, and as it had already proved that the flying characteristics were satisfactory only minor changes were necessary in the derivative. (*Courtesy F. E. N. St Barbe.*)

Both the D.H.7 fighter and the D.H.8 C.O.W. gun pusher fighter were abandoned, for much concentration was required on D.H.9 teething troubles and in supplying drawings and technical information to Westland for development into the 9A, as well as settling endless queries from the Americans over their production of the D.H.4. Above all, the twin-engined D.H.10 bomber had priority. Its structure was nearly complete, but work was held up by repeated labour difficulty over pay, and by late delivery of the specially swaged Rafwires. A second prototype was well advanced with the intention of fitting twin 360 hp Eagles, arranged as tractors on Farnborough's recommendation that it afforded greater efficiency. Had those who aspired to technical acuity in the early Air

Board really understood the techniques of aeronautical development, the RFC could have had, in the D.H.3 and the Avro Pike, machines of similar objective two years earlier; and with the advent of more powerful engines, they would have become proved strike weapons of greater and greater importance.

Like the D.H.10, the Avro 533 Manchester had to utilize twin BHPs initially instead of the envisaged Dragonflies. A technical data form of seven pages and a GA were submitted with the letter of tender, but was far from being a persuasive sales brochure, containing only sparsest information on performance and weights. The latter revealed Rafwires estimated at 97 lb to be slightly heavier than all the interplane struts. Other items

The first prototype D.H.10, officially named Amiens in accordance with T.D.I.506 issued in February 1918, had two BHP engines, duplicating the pusher arrangement of the D.H.3, and similarly had nosewheels. In this guise it first flew on 4 March, 1918.

were: tail unit 92 lb; main lift structure 1,000 lb; alighting gear 241 lb; fuselage with equipment inclusive of wing engine housings 680 lb; powerplant 2,048 lb; guns 180 lb; bomb-load 1,100 lb.

'The performance is estimated from results of the trials on the Rolls-Royce twin-engined Avro Type 529 at Martlesham Heath and assumes that the BHP motor will give 250 hp,' was the bald prelude to the statement of estimated speed at ground level as 105 mph. This immediately put it at a disadvantage with the 110 mph of the D.H.10, though climb was practically the same. 'Every endeavour will be made to improve on the performance', was the hopeful comment among the eight two-line paragraphs under 'General Remarks'. However, Roy Chadwick seems to have been tipped the wink that the D.H.10 was the favoured machine, and was urged to press on with the Avro 531, presently called the Spider, as a stand-by fighter in case the Sopwith Snipe encountered further difficulty. Essentially designed for mass production, this Bentley B.R.2 powered, V-Warren-strutted sesquiplane used a multitude of standard Avro 504 components to compete with the Camel fittings applied to the Snipe. It was an elaboration of Alliott Roe's similar use of 504 parts for his 1915 two-seat fighter. So far, no wholly war-time Avro design had met success, partly because it was not generally understood that with logical flight development an initially poor aeroplane can usually be made

The Avro 531 Spider with 110 hp Le Rhône appeared in April 1918, and located the pilot below a circular hole in the centre-section. Resulting concentration of weight near the C.G. helped give this Camel-sized fighter outstanding manoeuvrability.

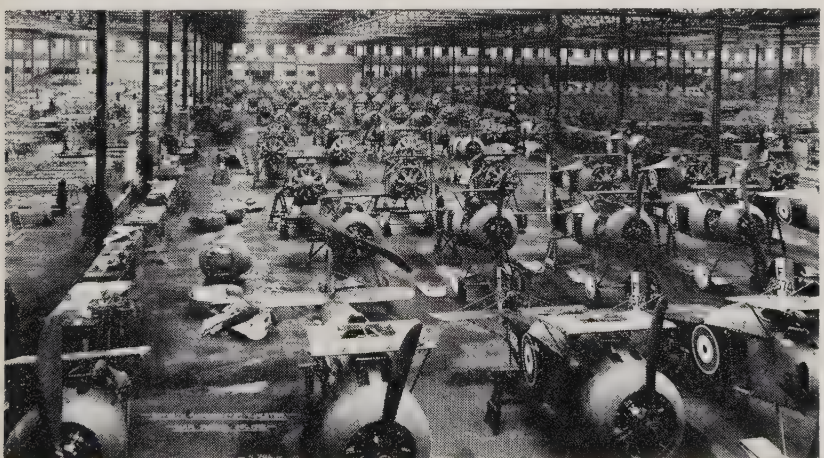
acceptable. Scores of new types were being hopefully designed and built by the Allies and the enemy, but if there was more than minimum difficulty with control and stability or performance they were invariably scrapped and a new design started. Time was at a premium. The tremendous output of Sopwith designs was indicative of hectic gambling that one in a diversity of projects would prove a winner. Of all the designing companies it seemed that only such men as Frederick Handley Page and Geoffrey de Havilland were unflurried by the wealth of opportunity, and concentrated energies on perfecting their designs instead of rushing hopefully into many more. Meanwhile every aircraft factory in Britain, whether a major company or new recruit, was crammed with great production lines, even though some of the types were already obsolete. Handley Page O/400s, Camels, Dolphins, S.E.5as, Bristol Fighters, D.H.4s and 9s, R.E.8s, trainer 504s and a multitude of Short seaplanes were pouring from the assembly shops.

Everywhere the sinews of war were preparing for what all knew must soon be the last great struggle to end the terrible carnage, and the Allies were determined to hang on until the mounting strength of the American armies could turn the scales to certainty. Already some of the United States' forces were in the firing line, and a handful of American pilots had long been members of the Escadrille Lafayette of the French forces. On 26 January one of their number, William Thaw, was commissioned Major in the United States Air Service, and given command of this famous French squadron, now renamed 103rd Aero Squadron USAS. His even more famous contemporary, Raoul Lufbery, already the greatest American air ace with 17 enemy aircraft destroyed, was assigned to the 95th Aero Squadron. There were many other pilots, not all of whom served in the Escadrille – and in the USA pilot candidates were being recruited by the thousand. Many were sent to Britain for training, the atmosphere of that time being brilliantly portrayed by Elliott White Springs in *War Birds*.

But production of aircraft in the USA seemed increasingly in disorder. Its immature industry, despite the world lead given by the Wright brothers at the beginning of the century, had produced less than 1,000 aircraft for the American entry into the European war. Optimistically the US Government had set a programme of 22,625 aeroplanes, with nearly as many for spares, together with 44,000 engines, and Congress had voted $640 million for military aeronautics, with a view to equipping 345 combat squadrons and a full supporting system. But it was clear that what Major Billy Bishop had said so disquietingly in Canada was true.

In France General Pershing had not cavilled at allowing American newspaper correspondents to send despatches home emphasizing the disadvantage under which American troops were placed through lack of aircraft. On 1 March the Senate Committee on Military affairs decided that delay in aircraft production, particularly for the D.H.4 bomber, was so serious that matters must be placed before President Wilson. It provoked a statement in the *New York Times*: 'President Wilson has become so concerned over conditions affecting aircraft production that he has set a special committee to work, under the chairmanship of H. Snowdon, Marshal of New York, to collate facts, with a view to remedying deficiencies. Walter S. Gifford, Director of the Council of National Defence, has been appointed to the new office of Director of the Aircraft Production Board, and will deal particularly with advisory relations between the Board and the War and Navy Departments and the industries involved.

'It is recognized that those who have responsibility for aircraft production have not been entirely at fault. Collision between aircraft interests and other government activities in obtaining sufficient quantities of the necessary high-grade timber; labour troubles; the breakdown of transport facilities, attributable in part to extraordinary weather conditions; the



Vast Sopwith production in 1918, at Kingston-upon-Thames, of Snipes to replace Camels. In the foreground are armoured T.F.2 Salamanders which were basically Snipes.

necessity for enlarging the number of cylinders of the Liberty motor to produce the best results for the speed – these are some of the things that have caused the delay.' Despite warnings, it was an echo of all that had happened in Britain, but worse.

It was not so much lack of organization as over-organization based on insufficient understanding of the exacting aircraft standards which was confounding the Americans. Matured and prepared wood was still in short supply but, under the direction of Colonel Brice P. Disque, the spruce-felling camps of Oregon and Washington were decimating the giant trees, many of which were 180 ft tall. In sawing and machining to fault-free 40 ft baulks, and then into planks, wastage was enormous, and at first some 2,400 cu ft were used to attain the 160 cu ft required for a medium-sized two-seater. Even when supplies of timber at last began to flow, big delays occurred through ineffective drying, for there were many technical difficulties to overcome in using heated kilns instead of the hitherto standard slow process of natural air drying. British companies, and the Government, watched the situation anxiously, for without huge American supplies our own vital production would dwindle to nothing.

Even given availability of spruce and plywood, American effort to build the D.H.4 was frustrated by changes of mind over technical specification and production details, partly brought about by the mandatory change to V-12 Liberty, for the American engine was having endless teething trouble. When failures occurred with early machines it usually meant a nose-over, because the Liberty brought the C.G. too far forward relative to the landing-wheels. Fire usually followed; soon the machine earned the depressing soubriquet 'Flaming Coffin', and morale dropped low. Not until early May was the first American-built D.H.4 Liberty-Plane ready for despatch to France. Armed more heavily than the British version, with two Marlin forward-firing guns for the pilot and twin Lewis on a standard Scarff ring for the observer, its rôle as bomber seemed overshadowed by need for defence, though it was intended to carry 320 lb of bombs on racks under the wings if some of the armament could be dispensed with. At an overload of 4,300 lb gross weight, compared with 3,500 lb for the British D.H.4, its handling was more sluggish; but take-off and climb were restored because of its 395 hp compared with 275 hp for the Rolls-Royce.

4

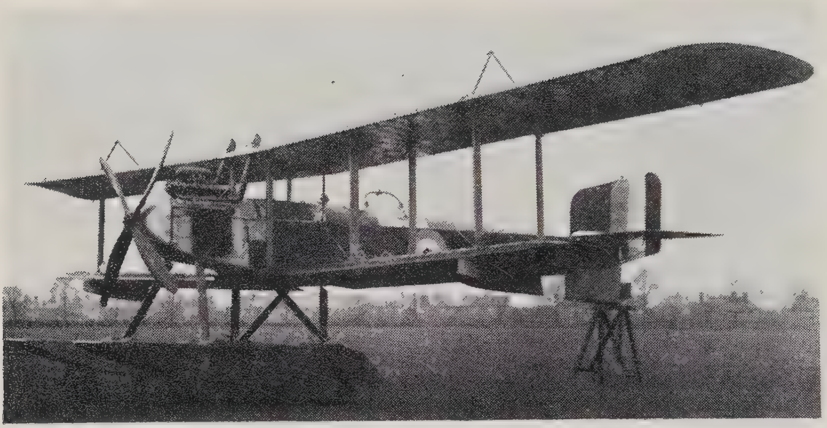
Quietly a new agitation for parachutes began. The old argument of pay-load was not quite so telling with currently powerful aircraft, and greater operational heights seemed to promise better chance of pilots getting clear. So many aircraft had fallen in flames that an increased sense of danger was on the surface of every pilot's mental load, adding to wear on nerves often near breaking from flying strain and its ever evident risk of sudden death. The chief objection lodged against parachutes was now not so much the difficulty of stowing but of launching from an aeroplane, particularly if out of control. The static line for opening was the stumbling

block. To that end Calthrop was devoting much experimental work, financed by steady orders of the Guardian Angel for kite balloons. But aeroplane pilots remained divided on the idea of parachuting. As one pessimistically remarked, 'A man descending in a parachute reminds me of someone condemned to be hung with a strong recommendation to mercy.' There is powerful instinct to remain in an aeroplane until the mounting process of disaster brings the last ditch where the only chance is to jump, and under conditions of war pilots were fatalistic. From the national viewpoint a pilot lost was merely money wasted in training; it was the gigantic slaughter in the trenches which mattered most.

At home it was not death but profits which worried the aircraft industry. The SBAC, as tax negotiator, had grown from the handful of five who convened the first meeting in 1916 to a powerful group supported by every firm in the industry, and collectively they sought to retain an untrammelled independence. H. White Smith, the original chairman in 1916, was re-elected in 1917 and for the third time in 1918, for he carefully held balance between various sections, preventing the tendency to split into the factions which weakened so many trade and industrial societies. Aero-engine manufacturers, although the strongest section after the airframe builders, were firmly categorized as sub-contractors; Nevil Gwynne, the biggest aero-engine producer of all, was chairman of this section.

The battle against excess profits duty exercised the SBAC even more than the valuable work it was doing on standardization of aircraft and aero-engine parts. The inconsistency of taxation against which the Society struggled arose from the fact that most pioneer aircraft constructors had sunk all their capital to keep their tottering companies going before the war, so profits had been negligible. In the enrichening war years current profit was therefore 'excess' and subject to crippling tax. On the other hand, many companies new to aeroplane manufacture had made enormous pre-war profits from quite other goods, yet would have collapsed altogether had they not entered the war-time aircraft industry. By law all were allowed to make their equivalent pre-war profits plus an extra 10 per cent, and of any additional balance they could retain a fifth. The position was as ironic as it was unfair, for there would have been no aircraft industry at all had not the pioneers tenaciously held on before the war, convinced that aeroplane building was their high vocation.

Dick Fairey was an instance where the yardstick of profits before the war was zero because he was then an employee of Shorts. His target was therefore to consolidate his three-year-old business, the Fairey Aviation Co Ltd, by every possible means. Already it was clear that he was a natural designer whose talents had been rationalized and made practical by the supremely logical Horace Short, for Fairey's designs bore the hallmark of his tutors, exhibiting the same sturdy characteristics. His Campania F.16 seaplane had proved very satisfactory, particularly when powered by the 275 hp Rolls-Royce Mk V. Few seaplanes gave as little trouble. Even the later Shorts, such as Type 320, had been influenced by



The Fairey F.16 Campania secured the first production contracts for Fairey designs and above 100 were built. A notable flight by the prototype was from the Isle of Grain to Scapa Flow piloted Sqn Cdr Maurice Wright.

the Campania, and with Oswald Short's new N.2B the resemblance was still more striking, for instead of the cubical radiator mounted on top of the fuselage, in manner so long favoured by Horace, a nose radiator similar to the Fairey was substituted. More than 100 of Fairey's design had been built, some of which were fitted with the 250 hp Sunbeam Maori because Rolls-Royce production could not keep up with the tremendous demand.

Success of the Campania led to a smaller derivative, the Fairey F.127 in the form of a single-bay seaplane with long overhangs to the top wing, and the long angular fuselage and fin which were becoming the hallmark of Fairey design. Intended for catapult launching using a ship-board mechanism designed by Armstrongs, F.127 was flown from the *Slinger* steam hopper which had been specially commissioned by the Isle of Grain

The Fairey N.9, F.127, is shown erected at Hayes prior to despatch to the Isle of Grain for vital catapult trials. Wings could be folded for carrier stowage and flaps were featured between the ailerons on the top wing and full span on the lower.

The 260 hp Sunbeam Maori II powered Fairey N.10, precursor of the Fairey III series, rigged at Hayes. Of greater power than its sister N.9, this two-bay version was an immediate success, and at the Armistice 70 had been completed.

The Fairey IIIB Bomber seaplane to specification A.2(b) was characterized by long overhangs to the top wing. Twenty-five were built powered by the 260 hp Sunbeam Maoris.

Except for the nose this Fairey IIIC is indistinguishable from N.10, and was modified from IIIB N2255 by fitting equal-span wings and a Rolls-Royce Eagle VIII engine. First production aircraft were delivered in November 1918.

Experimental Aircraft Depot and fitted with this gear. In manner typical of all good development, Fairey cashed in with a variation of this design, the F.128 – known as N.10 and later as Fairey III – which had equal-span two-bay wings. However, with both F.127 and 128 he used side-mounted radiators in the engine bay to reduce a forward shift of C.G. through locating the pilot close to the engine. Intended as a two-seat patrol seaplane, the wings could be folded, and on the prototype, Fairey's patent camber-gear was fitted full-span to the lower wing instead of to both and had ailerons on the top wing only. It was his most important design, for it proved equally successful in landplane form, though the radiator reverted to the nose when the V-undercarriage was fitted. Early in 1918, known as the Fairey IIIA, it went into production for the RNAS. Concurrently the company was working on yet another adaptation known as the IIIB, fitted with still bigger wings and slightly taller fin, designed to meet Admiralty specification N.2(b) for a two-seat seaplane bomber carrying a load of approximately 600 lb in racks under the fuselage disposed in front and behind the float axle.

Improved and bigger bombs were being intensively developed. At Orfordness tests had recently been completed with a giant bomb of 1,650 lb intended for attacks on the Saar and Rhineland by the Handley Page O/400 squadrons. Similar development was proceeding in Germany, though the long-range Gothas bombing England could carry only 400 lb greater load than the single-engined Fairey.

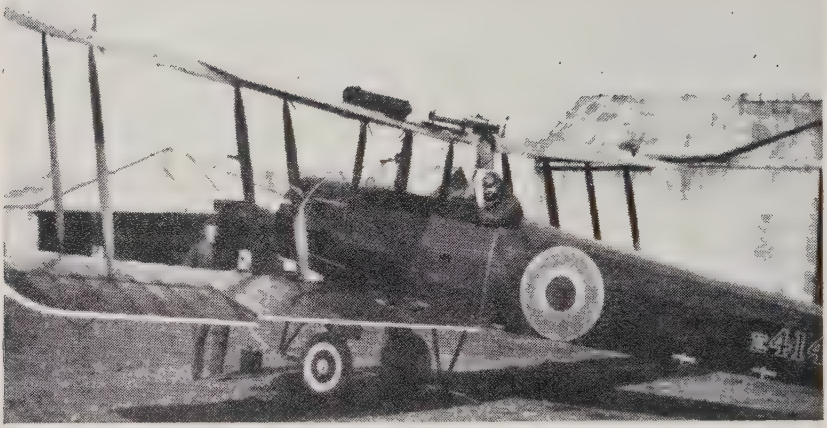
The air defence of London tried kite balloons with an apron of wires to intimidate hostile aircraft but night flying fighter aircraft proved more effective than either balloon or gun barrage. (*Imperial War Museum.*)

There had been a mere 30 bombing raids on this country since the previous March, but though material damage was inconsiderable the fact that civilians were being killed and injured made everyone apprehensive, and had gone a long way to diminish production because great numbers refused to leave home on moonlit nights. Yet the defence system was now highly organized. It was centred on the London Air Defence area, and Major-Gen E. B. Ashmore, CB, DSO, had arranged concentric rings of defence. At various points within the City area balloons in small series were inter-connected and cables suspended from the line to form an apron.

With the first German aeroplane raids on London there came urgent demand for night-fighters. Sopwith Camels were modified by interchanging cockpit and fuel tank so that the pilot was behind the wing trailing edge. The centre-section was left open for upward view and fitted with twin Lewis guns on Foster mountings. The aeroplane was dull black to prevent searchlight reflection. (*Imperial War Museum.*)

News of this 'secret weapon' was carefully made known to the Germans, and it caused their bomber pilots to keep high, for the curtain was alleged to extend up to 8,000 ft. But balloon aprons were neither so wide nor flew as high as the enemy expected. Lifting capacity was limited and it was difficult to prevent the inter-connecting cable dragging the balloons together. The suspended wires of 6 swg were so thin, and therefore invisible, that enemy pilots often imagined there were aprons when balloons alone were flying. Holt Thomas's staff at Airships Ltd devised systems of illuminating balloons both to show the cloud height and give evidence to the enemy that balloons were flying. More than a mile above them an effective gun barrage could fill the sky on the line of approach of raiders. Above were the night-flying fighters.

Although the Sopwith Camel had been considered too tricky for such night-flying, its capability had been put to practical test early in the autumn of 1917 when Capt C. J. Quintin Brand and Lieut C. C. Banks attempted to chase hostile night raiders. Unfortunately the unshielded guns gave a blinding flash on the pilot's line of vision, so radical modification was made by interchanging the position of standard aft-mounted fuel tank and pilot, enabling him to operate twin Lewis guns carried on Foster mountings



The long wings of the Avro 504K powered by the 130 hp Clerget enabled 18,000 ft to be attained with single-seat versions which were made for Home Defence. The gravity tank was repositioned to port and a Lewis gun fitted on the centre-section. (*Imperial War Museum.*)

on the centre-section. At once the Camel proved an agile supplement to the obsolete B.E.2e single-seaters of the Home Defence squadrons, to which had been added 60 Sopwith 1½-Strutters withdrawn from France and converted to single-seaters with the pilot in the rear cockpit and Lewis guns like the night-flying Camel.

With the Camel's problems licked, the B.E.2es were dumped expeditiously on the scrap heap, and superseded by the new version of the Avro 504 in which the familiar lobed cowling and distinctive pear-shaped side fillets were replaced by a Sopwith-type annular cowling. The 'spider' front bearing for the rotary was changed for an overhung mounting which H. E. Broadsmith devised in the form of two rear bearer plates suitable for any type of rotary from Mono to 130 hp Clerget following a request by Smith-Barry at his Gosport School of Flying for an even more powerful machine than their J type, the cowling of which had insufficient diameter for a bigger engine. Irrespective of make and power, all Avros with the new cowling, whether modifications of the J or not, were hereafter referred to as the 504K, and were being produced by the Avro factory at the tremendous rate of 100 a week, as well as spares, and kits were being made for assembly at Abukir as a training centre for the Eastern Front. No other aeroplane in the world has so universally endeared itself to pilots. Here was the final triumph of Alliott Roe's 1913 design, and as a generic type it already had the longest life of any used by the RFC and RNAS. When it was decided that the soggy B.E.2es should be replaced, a single-seat version of the 504K was made, fitted with the 110 hp Le Rhône. As with the other current night-fighters, a Lewis was carried on a Foster mounting above the centre-section, the front cockpit covered, and the pilot given the rear location. Five Home Defence squadrons received the

initial allocation of these machines, but though aircraft were plentiful the problem remained of locating night invaders with the aid of signals from searchlights and flares, and eventually from limited radio assistance.

5

Ever since taking office, Lloyd George had been at loggerheads with the War Office, and on 16 February had at last dislodged his greatest antagonist, General Sir William Robertson, Chief of the Imperial General Staff. General Sir Henry Wilson took his place. Meanwhile Field Marshal Sir Douglas Haig had been pressing for more and yet more men, claiming that if there was a German attack he had insufficient strength to resist, and thus could not send reserves to the Fifth Army commanded by General Gough.

The Air Force Estimates, introduced in token form on 23 February by Major Baird, gave Pemberton Billing and his co-critics opportunity of once again attacking the weakness of Air administration. Baird read a typed speech which a reporter described as 'better suited to a Pleasant Sunday Afternoon lecture on "Our Gallant Airmen" than to serious exposition of the internal economy of the Air Force and the fate of the two Flying Services', for all he did was to define the duties of various members of the Council and the several divisions of supply and technical services.

Mr Joynson-Hicks opened the debate, saying: 'Three months have elapsed since the Bill passed into law and ten weeks since the Air Council was created. I do not want to push the Hon and gallant gentleman too far, but I do want him to use the utmost despatch to secure the issue of the Orders in Council so that we may have a real union of the two Flying Services.' He then proceeded to make informed comment on the engine and aircraft supply position, stressing that it had not attained the estimated figures given to the House by the Prime Minister in July of the previous year: if necessary the number of factories must be doubled to secure sufficient production, and he added the warning: 'Our primary reliance must be upon ourselves. We went into this war without the United

The Blackburn R.T.1 Kangaroo derived from the G.P. seaplane by substitution of a two-wheel undercarriage for each float. Four 230 lb bombs or a single 520 lb bomb were suspended in a central internal compartment.

States, and kept in it without them for two and a half years, and we are prepared to go through, even though we do not get the help that we expect from our Allies.'

Colonel C. Lowther took a more vehement line: 'It does seem to me surprising and disconcerting, and it certainly augurs very badly for the future, that during a Debate on a Service on whose superiority victory may depend, neither the Prime Minister nor the Leader of the House nor any Minister sitting upon the front bench has thought it worth while to be present.'

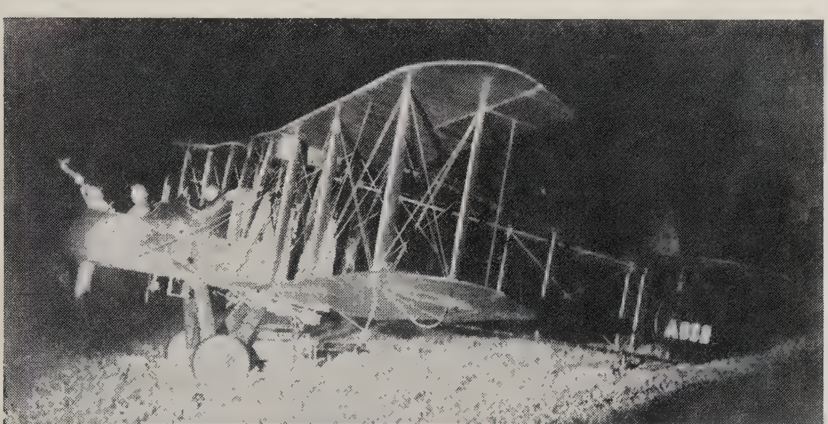
Several MPs made speeches ranging from Air Defence to cost of training, medical requirements for pilots, and the growing number of accidents. Finally Pemberton Billing took the floor, backing Lowther with bitter sarcasm: 'This afternoon we have had another experience of an Air Debate in the House. We have seen the extraordinary interest evinced in the air by this House. Here we have had an audience which has fluctuated from five to twenty-five. Is that because they are satisfied all is well or is it because they are utterly exhausted with the general proceedings of the House, or perhaps because they think criticism of aeronautical matters at this late date can have no useful bearing on the issue of the war? It fills me with disgust.

'I take exception to the fact that these Estimates are introduced as a token vote. They would have been better introduced had we known the amount which it was proposed to spend on the Air Services. Is it £1 million or is it £10 million? I am sure that the pilots today would far sooner hear what we were going to do for them than a long dissertation on what they are doing for us.

'The Hon member for Sunderland asked the question whether it is a fact that Lord Rothermere contemplates resigning from the position of Air Minister. The Prime Minister knew well that if he gave the position of Air Minister to the proprietor of a popular paper, who was the brother of the proprietor of many other popular papers, the Air Service would loom large in the eyes of the public. It seems to me that the principal thing which occupies the mind of the Prime Minister is that he should get a good Press. But we cannot beat the Germans with ink. Yet I am confident that with an adequate Air Force we might bring this war to a successful conclusion in 1918, and sooner than by any other decision that our political or military advisers could take. This can only be done by making up your minds on one policy, and sticking to it through thick and thin. That policy, I submit, is to standardize three distinct types of machines respectively for night-bombing, day-bombing, and fighting.' Conveniently he overlooked his earlier tirades against standardizing the B.E.2c, which had led to the time-wasting public enquiries of 1916.

'When we come to the question of engines,' he continued, 'I think it is correct to say that the Naval Air Service has been employing 26 different types, and the RFC 18. I ask the four or five members present to appreciate what it means to employ 44 different types of engine with some

200 or 300 spare parts for every engine. Though the Germans have very little imagination, we would do well to copy them in some things, and in this in particular. Anyone who has the opportunity of inspecting a German machine will find, once you have torn the fabric off, that the work underneath, while efficient, is comparatively rough. Where workmanship is not necessary it is not put in; where workmanship is necessary it is put in.'



Illumination for night-operations was crude and temporary but F.E. pilots had the best possible view, the machine was easy to fly and the undercarriage very forgiving, yet many were wrecked by forced landings because the home aerodrome could not be located. (*Fleet Air Arm Museum.*)

He wound up by criticism of the Air Council. 'The only thing they have done so far has been to set up a noisy defence of London, and to carry out one or two minor raids into Germany. They may have a very fine programme in view, but if anybody in their senses thinks that their noisy defence, from the hundreds of guns we have set up in London, had the effect on Monday night of driving off vast squadrons of enemy aeroplanes back to Germany, they were never more deluded. What we want is co-ordination in defence; a complete system. If the ordinary small raiding squadrons want to go through the barrage let me assure the House they will go through it. What we want, if I may repeat it to the House, is offence and not defence.' But that had been the constantly reiterated theme of Trenchard for more than two years.

Currently the *Gazette* made known that Maj-Gen J. M. Salmond had succeeded Maj-Gen Sir Hugh Trenchard as General Officer Commanding RFC in the Field. 'Though it appeared when he vacated the Office of Director-General of Military Aeronautics,' wrote a commentator, 'that it meant he was taking a backward step, he was taking another step forward in his brilliant career. Only an officer of exceptional ability could possibly have been appointed to succeed General Trenchard, so the wonderful work which the RFC has been doing in France since the beginning of this year shows that the high morale of the Corps is being fully maintained.'

This led to speculation on Trenchard's future. With whom had he got at loggerheads?

There followed a Memorandum in the first week of March defining the 'Transfer of the Royal Naval Air Service and Royal Flying Corps to the Royal Air Force'. C. G. Grey from the fastness of his editorial office, his civilian status imposed by a damaged leg, blithely commented: 'In the general way the outlook for everyone concerned with Service aviation has never been so bright as today. Compared with the Army, officers and men of the Air Force are, if anything, overpaid, for the lot of the aviator in war is in every way preferable to that of the infantry-man, and the life of an Air Force private is that of a gentleman compared with the existence of the infantry.'

The Sopwith 2F.1 with 130 hp Clerget was the shipboard version of the Camel, and had a shorter centre-section mounted on steel-tube struts. The fuselage was jointed at the ply-panelled juncture behind the cockpit in order to facilitate storage of spare components. (*Imperial War Museum.*)

Appendix 1(a) of the Memorandum gave the pay of officers. A General received £2,500 a year, a Brigadier-General £1,000; a Major in the flying branch had 32s a day, while a Captain received 19s basic and 8s a day flying pay, compared with a 2nd Lieutenant who received 10s a day and the same flying pay. It was not generous for the death or glory boys. Their spur was patriotism; the token of their achievement perhaps a silver or bronze medal, but probably a wooden cross.

Commodore Paine, the great founder of CFS and Cranwell, was now promoted KCB. His post as Director of Air Services was abolished, and he was appointed Master General of Personnel on the Air Council. As one journalist put it: 'Despite the contempt of a certain class of naval officer, the inability of seagoing senior officers to understand the importance of aircraft, and continual hampering and hindering at the Admiralty, the RNAS has won fame as a fighting force. And for the fame which it has won, no small share of credit pertains to Sir Godfrey Paine. The fact

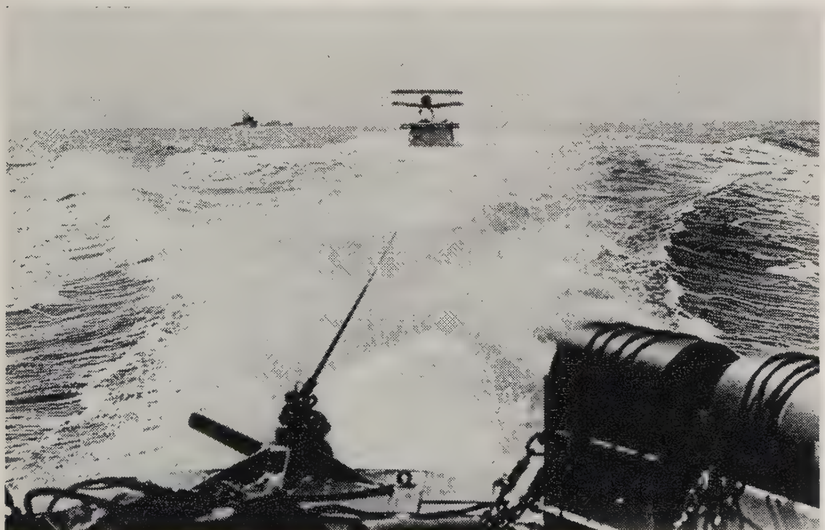
that he is no longer one of their Lordships at the Admiralty is a distinct loss to that august if somewhat salt-encrusted Council. A little of the mentality of the upper atmosphere was calculated to clear the air in their deliberations. It is seldom that one finds receptivity to new ideas in any head of which the corresponding sleeves bear more than three gold stripes and an executive curl, and the fact that Sir Godfrey Paine has escaped the customary hardening of the mental muscles, despite his distinctively nautical aspect, makes it the more regrettable that the Navy should lose his valuable services. None the less, it is an ill wind which blows nobody any good, so one can say with conviction that the Admiralty's loss is the gain of the Royal Air Force.'

To that title the combined Flying Service would not be consolidated officially until 1 April.

On 3 March Russia signed Peace terms with the Central Powers at Brest-Litovsk. Defined by H. G. Wells as a 'crushing and exorbitant Peace, dictated with the utmost arrogance of confident victors', it was sombre warning to the Allies of what would happen to them if Germany won the imminent struggle. It was now very clear that the holocaust was about to break.

There was faint reassurance from the fact that at last the United States pilots in France were able to make their first operational flights across the lines on 19 March, using American-built aircraft which had been delivered to the 94th Squadron of the 1st Pursuit Group.

Two days later the German offensive on the Western Front re-opened in the shell-torn, devastated area of the Somme. There was none of the



A daring use of the Sopwith 2F.1 was operation from a lighter towed at 36 knots by a destroyer. Lieut S. D. Culley made the first successful take-off on 31 July, 1918, and on 11 August shot down a Zeppelin after launch by this method. (*Fleet Air Arm Museum.*)

vast artillery barrage which usually gave warning of attack. Through dense morning mist hordes of grey-clad Germans suddenly appeared, attacking the startled men of the Fifth Army in wave after wave. The front collapsed completely, and the British troops were driven back in disorder on a 50-mile front from the Scarpe to the Oise. There were no big reserves available to General Gough, nor was there any co-ordination between British and French Commands. Only hastily contrived holding points and the dogged tenacity of British morale prevented an immediate breakthrough. As detachment after detachment dropped back, their stores, huts and buildings behind the lines were burnt to the ground while guns and limbers were pulled away across the open fields by the teams of horses still used as motive power. Eastward of this great retreat, a broad front of Germans slowly moved forward over ground criss-crossed with trenches and uniformly pitted with shell holes which impeded progress of their supplies. But they seemed invincible.

In Parliament there was rising anger, though Lloyd George had earlier admitted that pressure was building up on the Front and the British Fleet might prove the final bulwark of these Isles. Bitter recrimination arose, pointedly directed towards Gough – though the newspapers, prompted by a government directive, urged people not to panic and emphasized that this was the supreme moment when everyone must keep level heads, for at this point we would win or lose the war.

'Without for a moment believing that the fighting over the old Somme battlefield is the decisive battle of the war, as so many writers have said, one may safely say that it is the greatest battle of the war,' presciently wrote one of the correspondents. 'The systematic Russian defeats of the period of Tannenberg and the Masurian Lakes probably involved greater numbers of men, but their results were less important. None can believe, by any stretch of imagination, that either France, Britain, or Germany can be so defeated in this battle as to be put out of the war immediately or permanently disabled from future recovery.

'In the case of the Allies such defeat is even less possible than in the case of Germany, for, with America only just getting to work, the Allies' possibilities for recuperation after a set-back are greater than Germany's. One is inclined to think that the effort is Germany's great attempt to force a decision before America's full weight is felt, and the failure of that attempt may make the battle decisive in that it may be the turning-point of the war to the extent that Germany may never again make a great attack.

'In the great battle now in progress, the Hun has, as usual, all the luck of the weather. Thick mists to hide his early morning assemblies from our air scouts, and to make observation difficult all day long. Dry ground on which to manoeuvre, where we have always had wet. Still air, so that his poison gas is not blown away quickly. In spite of these disabilities, the RFC and those RNAS and Australian squadrons associated with it, have done marvels. Their ascendancy over the enemy in the air is greater than

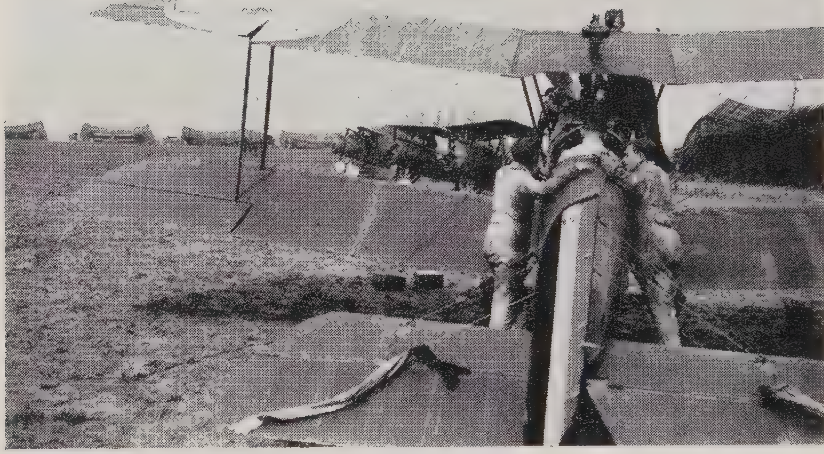
ever. The fact that, despite that ascendancy, the course of battle should have gone adversely shows that the time has not yet come when wars are won in the air. Yet if the Allied Flying Services were sufficiently multiplied, as they will be in due course, the war on the ground might be very greatly influenced by the systematic invasion of Germany. Political and politico-military intrigue has hindered the arrival of that day, but things are changing for the better. During the past week our Flying Services have fought the greatest fights in their brief but notable history. Next week there emerges the Royal Air Force. Thus they expire in a blaze of glory worthy of their great future. RNAS and RFC *ave atque vale*!'

But by that time the British Forces had been forced back to the Somme, with the Germans still pressing inexorably forward in a great salient. Tension in Parliament mounted. Lloyd George was elusive when questioned on the high figures he had given of the strength of the British Army. Politicians, civil servants, and High Command were ducking the blame. Inevitably Sir Hubert Gough was relieved of command, and on 26 March General Foch was appointed Commander-in-Chief of the entire Allied armies on the Western Front.

6

Maj-Gen Sir John Salmond had at his disposal in France 1,232 aeroplanes allocated to 63 RFC and RNAS squadrons, to which was added one special duty flight when the Royal Air Force and the Women's Royal Air Force were officially established on 1 April. Among pilots and observers there was sorrow at the loss of former identities in the fusion of traditions for the new Service. Everyone now had military rank, but uniforms remained a medley of Regimental, RFC, and RNAS. The Camel, S.E.5a, Bristol Fighter, D.H.4, and R.E.8 were still the mainstay of the squadrons,

Line-up of No. 1 Squadron S.E.5s at Clairmarais near St Omer in July 1918. Pilots are in the foreground while mechanics pose with the aircraft. Note variety of uniforms. (*Imperial War Museum.*)



Air mechanics of No. 32 Squadron at Humières aerodrome work on a much patched S.E.5a which has had a new centre-section. Against the typical background of canvas hangars is a Flight of Sopwith Camels. (*Imperial War Museum.*)

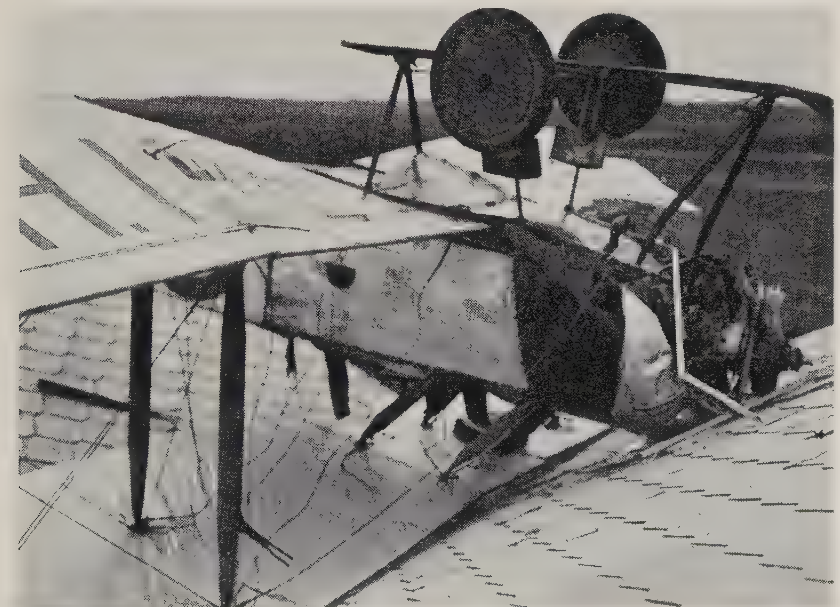
with Short seaplanes and Felixstowe flying-boats as the basis of sea operations, together with blimps. Several squadrons still had earlier types, but generally aircraft nearing obsolescence were used in other theatres of war: Palestine, Mesopotamia, Macedonia, and Italy where they rendered invaluable service, though of more desultory nature than the enormous activity on the Western Front. Over France and Flanders the local sky often seemed filled with uncountable numbers of opposing aircraft swirling in vast dog-fights – though the day of individual combat exemplified by the late Capt Ball, VC, and the still active Major Billy Bishop, VC, was gone; yet Bishop was never more successful than on his return to France on 22 May in command of No. 85 Squadron, for he shot down 25 enemy aircraft in 12 days. Among the new leaders of group fighting was Capt Edward 'Micky' Mannock, who after a 'rest' in England had returned to France on 31 March as Flight Commander of the newly formed No. 74 Squadron, and in three months brought his total to 59. Next highest scoring pilot was James Thomas Byford McCudden, whose 57th and final victim fell on 25 February. Ten days later McCudden returned to England on a 'rest' instructional mission, and in the same week in which the RAF became consolidated he was decorated at Buckingham Palace with the VC, DSO and Bar, and Bar to his MC. Many others were fighting their way to equally brilliant success; yet for every pilot who became an ace there were a hundred and more unsung who did their daily dogged best as they flew their artillery observation aircraft, carried out bombing raids, or hunted enemy submarines.

At home the organization and effort to supply more and more pilots was at its peak. There were as many training squadrons as on active

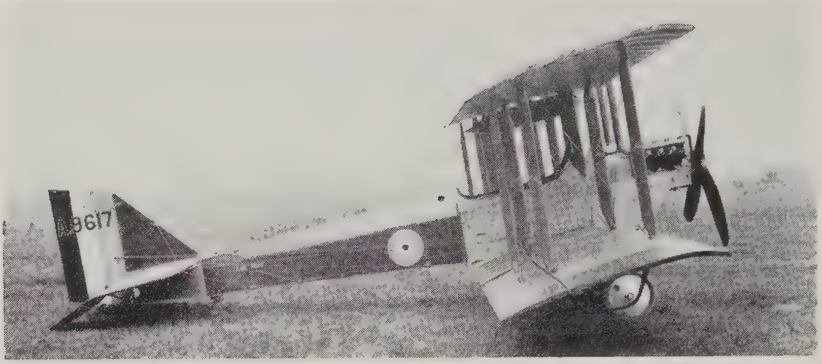
service. Yet the pace was being forced, and the number of crashed aircraft exceeded those brought down by the enemy in France. Training fatalities from accidental spinning were alone as much as 40 a month in 1918, yet this was only a fraction of the total. No wonder that in debate on the Air Force Estimates, Colonel Sir Hamar Greenwood said: 'I want to ask the Hon and gallant gentleman in charge of the estimates if it is a fact that during the year 1917 we lost more flying men in schools of instruction than we did on all the Fronts?' Colonel Sir C. Seely and other Members endorsed his request that the Air Ministry should take note of the very serious number of accidents.

Training Command was all too aware of the growing toll, but to ensure adequate replacement of wastage it was essential to speed training. Inevitably this meant that trainees were given operational aircraft as soon as they had completed a mere 10 or 20 hours preliminary flying.

To investigate matters, Lieut-Col Mervyn O'Gorman was appointed chairman of an Accidents Committee. One of the first tasks was to discover why the D.H.6 'Clutching Hand' was proving dangerous as a trainer. In his endeavour to provide low landing speed and straightforward non-spinning characteristics at the stall, Geoffrey de Havilland had employed a wing section having greater centre-line camber and under surface concavity than usual, and for simplicity made the biplane structure without stagger. The result was a machine with a landing speed of only



A landing from which the pilot could walk away was jocularly regarded as a good one. Slow landing speed afforded by light wing loading was a great safety factor as shown by this Avro 504K which hit a roof. (*D. F. Woodford.*)



The standard production D.H.6 'Clutching Hand' had rectilineal rudder outline and triangular fin replacing the curving de Havilland shape. Wing camber had pronounced curve and the front spar was abnormally far back with consequent long nose ribs.

35 mph and the impossibility of stalling inadvertently. Unfortunately his effort at making a simple cheaply produced airframe led him into the trap of foreshortening the nose by placing the engine too far back. This resulted in a machine which was in trim at 50 mph 'but could not be flown hands-off as the equilibrium was unstable'. Yet at 100 mph a large pull of some 25 lb on the control stick was needed. This was inconsistent with the light response afforded by an unstable aeroplane when in trim. Exploratory wind-tunnel tests were put in hand by the RAE*, and a number of test flights made to investigate behaviour.

The Officer Commanding the 15th Training Squadron reported: 'I have looped a B.E.2c and 2e about a hundred times, so was prepared to treat the D.H.6 in the same manner. I started a loop at 1,200 ft and everything seemed all right until I had got just over the top and the stick back as far as it would go, but the nose would not come down. The throttle was still fully open and the machine was going downwards upside-down very rapidly. I moved the stick backwards and forwards, but the movement of the elevator had no effect whatever and the machine was still in the same position. I then decided that the only thing to do was to switch off, which I did, and the nose at once came down, completing the loop at under 50 ft from the ground. Had I kept the throttle open another two or three seconds I should have hit the ground. It seems to me that when in that position the elevator was working in a vacuum. I talked to several people who saw a D.H.6 crash, and there seems little doubt the same thing happened, as the machine went downwards upside-down with engine full on.' Another pilot from the training division confirmed that the machine tended to hang at the top of a loop, and whatever the speed at that point it was impossible to get it over unless the engine was cut off. He found that the D.H.6 could not be made to spin, and agreed that in dives the pull on the controls was very considerable even at 75 mph. He added:

* Formerly the Royal Aircraft Factory.

'Generally speaking the machine as usually rigged is unsatisfactory for training purposes. The low landing speed and the freedom from danger by stalling is likely to lead to accidents when the pupil is transferred to Service machines.'

The Royal Aircraft Establishment at Farnborough – now always referred to as the RAE to distinguish it from the RAF – found from wind-tunnel tests that there was a critical angle of descent of about 75 degrees, beyond which elevator control was inadequate as the aeroplane assumed semi-stable attitudes either when in a near-vertical path, or gliding inverted at an angle between 30 and 40 degrees. Farnborough pilots conducted a series of tests to establish the control force at various speeds, engine on and off. From these it was deduced that behaviour could be improved by reducing the tail setting to get the unstable trimming attitude beyond that of no lift. This should make it out of trim and tail-heavy at all speeds, but by fitting an elastic bungee to exert a forward pull on the control column, level trim ought to be restored without large hand forces at high speed; but further flights showed that despite improvement there was still an increasing pull with speed. Elevator chord was therefore reduced, and the top wing moved back 9½ inches to bring the relative centre of gravity forward by 5 inches so that the aeroplane became nose-heavy and required greater negative tail setting. The pretty rudder profile standardized by de H. was replaced by a simple triangular fin and a considerably smaller rectangular rudder to match the small chord elevators. These modifications still failed to give a full solution, so a 4-inch strip of the mainplanes' steeply down-curved leading edge was removed to form a less cambered section, and on Geoffrey de Havilland's advice backstagger was increased to 11 inches. At this the danger seemed eliminated, but by

As a result of safety modifications the rudder and elevator area of the D.H.6 was decreased by reducing the chord, the mainplane leading edge cut back several inches, and the wings rigged with negative stagger which eventually was as much as 11 inches.

now it was obvious that the D.H.6 was not really suitable for training, and that instructional machines should, like the Avro 504K, have reasonable longitudinal stability as well as light control. Accordingly all D.H.6s were progressively relegated to other duties, among which many of the backstaggered version found employment for anti-submarine work.

Even more worrying were Camel crashes through spinning, for the S.E.5a was comparatively immune when flown under similar circumstances. Camels were usually rigged tail-heavy with full tank and were then longitudinally unstable like the D.H.6. This was accentuated when the lighter Le Rhône was substituted for a Clerget, or guns and ammunition were removed. Usually a continuous forward pressure of some 14 lb was required on the control column when in normal horizontal flight; any relaxation ended in a stall, and so did engine failure unless the pilot instantly dived the machine. In the course of evidence on the machine's behaviour, most pilots drew attention to the necessity of applying full left rudder in a steeply banked right-hand turn. Torque and slipstream produced unsymmetrical settings of aileron and rudder, but not effects dependent on rate of turn to any great extent, the gyroscopic couple alone being capable of that. Propeller and engine revolved clockwise, viewed from the pilot's seat, so when the aeroplane was turning right the gyroscopic couple put the nose down, countered by top, that is left, rudder and back elevator. Analysis showed that the effective couple produced by a given setting of the rudder on a Camel was 40 per cent less than for the S.E.5a, whereas the gyroscopic couple to be counteracted was more than twice as great. To make the two machines equally effective would necessitate doubling the Camel's rudder area.

It was immediately evident with a Camel that violent use of elevator must be avoided, for when the stick was pulled back too hard the machine

This Camel had a luckier end than many after being forced down in the fighting area, for the damage is not great after tipping into a shell hole at the end of the brief run, for landing speed was low due to light wing loading. (*Imperial War Museum.*)

To reduce instructional crashes a two-seat dual version of the Camel was made in the summer of 1918 by conversion from a standard single-seater and locating a second cockpit in the position normally occupied by the petrol tank which was reaccommodated in smaller forms in front and behind the front cockpit. (*Imperial War Museum.*)

would not complete a loop. By contrast, full left rudder could scarcely keep a loop straight, but surprisingly when it came to spinning, the rudder was relatively unimportant. As soon as the stick was pulled hard back and the machine stalled fully it would flick into a spin, but quickly stopped if the column was eased slightly forward with other controls neutral, and could be stopped almost instantly by reversing the rudder as well as giving forward stick – though this induced a violent manoeuvre, and lack of skill could result in the machine entering a reverse spin. If the pilot became dizzy the Camel would not come out of a spin with controls free, and only slowly if all controls were held central. That forward push on the stick was essential. Some aeroplanes spun even faster than the Camel, with a period of $1\frac{1}{2}$ to 2 seconds a turn, and 150 to 200 ft lost.

O'Gorman and many instructional pilots agreed that transition from the Avro 504 to the Camel had hitherto been too rapid, for the Avro was much more difficult to spin and recovered very easily, nor did it require to be held down at the end of a spin in the manner essential with a Camel. Its controls were not so sensitive, the spin was slower giving less tendency to dizziness, and there was plenty of time to correct mistakes. As no intermediary machine had hitherto been envisaged there was general feeling that a two-seat dual-control Camel should be produced; meanwhile much longer *ab initio* training must be given to every pupil.

7

Accidents were by no means the prerogative of the RAF. The Westland Works of Petters and the Nieuport and General Aircraft factory had each suffered disaster with their prototype fighters.

On 1 March the Nieuport B.N.1, fitted with the sixth B.R.2 so far built, was flown to Martlesham, but the engine ran inconsistently. On the 9th the machine went to Sutton's Farm for comparative trials between the two-bay Sopwith Snipe with B.R.2 engine, the slightly smaller Boulton and Paul Bobolink which had the fourth B.R.2, and the little Austin A.F.T.3

The Boulton and Paul P.3 Bobolink, at Mousehold aerodrome, was originally named Hawk. All-round performance was considered better than that of the Snipe, though difficult access, poor view, and narrow undercarriage were drawbacks. The rudder was later increased in height with an unshielded balance above the unchanged fin.

Osprey triplane which had the third B.R.2. Although the 23 ft span Osprey was a nimble performer compared with the slower manoeuvrability of the three larger fighters, it was outclassed in speed. There was little to choose between Bobolink and Snipe, but both required increased vertical tail area, particularly larger rudders to prevent swinging when taxi-ing. Indeed, the Bobolink's narrow undercarriage added to the difficulty and made it unacceptable in that first form, though Capt Frank Courtney, a pre-war bank clerk in Paris who joined the Boulton and Paul drawing office and now was finding his true vocation in flying, had conducted the maker's tests and considered any difficulty in taxi-ing was negligible. The case for concentrating on the Snipe had all in its favour, for it was virtually a more easily handled Camel – of which there were ten squadrons in France, each 24 aircraft strong instead of the previous 18 to a squadron. Nevertheless, of the four contenders at Martlesham, the clean, **I**-strutted Nieuport was easily the fastest, and except for the residue of doubt about wing twist, it seemed for a time that this unconventional biplane might be added to the Snipe as it offered equivalent production advantage in using many S.E.5 components. Certainly the pipe-puffing Henry Folland was a figure to be taken seriously in assessing the merits of rival machines, for his S.E.5 was widely regarded as the supreme fighter of the war, despite the conviction of many great fighter pilots that the unstable Camel was better, as indeed it may have been under certain conditions of air fighting. But his Nieuport met disaster. On 10 March it was flying from Sutton's Farm when it caught fire and was completely destroyed. No details of the accident survive. Unfortunately time was too short to make another prototype, so the Snipe adherents got their way.

It was in more stupid manner that Westland encountered disaster with their Wasp-engined, 23 ft span Wagtail, the rival of the B.A.T. Bantam F.K.23 which had been tested by Peter Legh at Hendon in February and

found highly manoeuvrable, but with a vicious spin. Sopwiths at last had finished their monocoque-fuselaged, Wasp-engined biplane which had wings 5 ft longer than the 20 ft Bantam. Of the three, the little Wagtail was the more conventional and the first to fly. Tested by Capt Alexander, it had been looped on its initial flight, so pleasant were the flying qualities and so rash the pilot. The unexpected followed.

Westland clearly had high hope of success with their fighter when Capt A. R. Boeree, RAF, went to Yeovil a few days later to conduct handling trials with the first experimental D.H.9A to receive the American Liberty engine. 'I was unpopular there,' he recollected, 'because I would not let civilians smoke cigarettes while pouring petrol from cans into the tanks. They complained to the chief, R. A. Bruce, who told them it was an order. When I took up the aircraft, he came up with me. They used to have cows on the little aerodrome, and they scattered all over the place when I came in to land. Instead of its designed gliding speed of 70 mph this 9A hurtled down at 120 mph. I had to think quickly. It could be flown OK with power on, so I opened up, went round again, and flew it on to the ground, got out, and cursed all within sight. So to make it balance we poured 21 lb of lead into the rudder-post. The chap who had been smoking was now determined to show me that it was quite safe, and pushed a burning cigarette into a can of liquid petrol. Luckily it did not

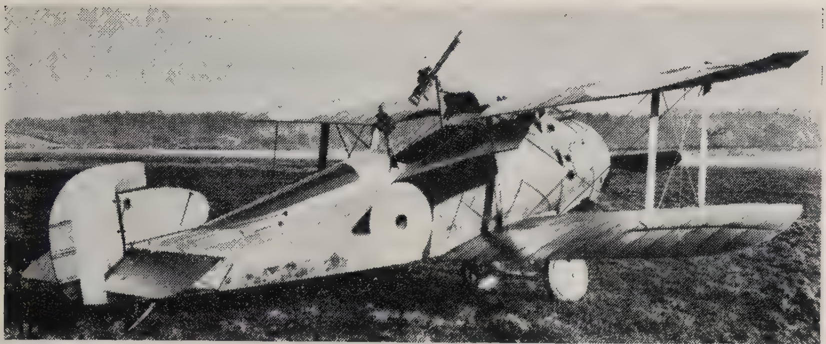
Westland attempted to eliminate the upward blind spot of their 23 ft span Wagtail light-weight fighter, but it reduced the aerofoil efficiency of an otherwise excellent aeroplane in the same class as the B.A.T. Bantam and Sopwith Snail, all equally defeated by the 170 hp Wasp engine. The prototype had equi-dihedral wings. Accessibility of the gun was noteworthy.

Westland-built D.H.9A C6122 which was fitted with the first Liberty engine. It is seen awaiting test flight by Capt A. R. Boeree at Yeovil on 19 April, 1918. The engine was rated at 422 bhp at 1,750 rpm. The first squadron completely equipped with the D.H.9A was No. 110 and they arrived in France as part of the Independent Air Force on 31 August, 1918.

explode – but I was far from impressed and told him the danger was that the vapour would ignite.

'I took the 9A to Martlesham – after refusing to fly it again until the rigging was checked, with the result that Westland staggered the top wing 2 inches forward. While I was in Suffolk, Bruce sent me a picture of a burnt-out hangar at Yeovil. The chap with the cigarette had tried it once again, and this was the result. And there amid what was left of the hangar were the ashes of the Wagtail – the first British war aircraft to fly with an A.B.C. radial engine. They had to build another prototype, which delayed tests for six months, and it was therefore not ready for production until after the war.' Arthur Davenport, at that time chief draughtsman, remembered the incident when he was told this story, and he says that concurrently they were well immersed in design for a two-seat fighter, later known as the Weasel, which was to be powered by the much vaunted Dragonfly.

A machine which suggested affinity with Bristol Fighter design was the promising Westland Weasel intended as its successor. Noteworthy was the divergent wing-tip gap which resulted in better lift characteristics than conventional dihedral. Other radials were tested in subsequent prototypes.



The private venture two-seat Sopwith Bulldog fighter was built to the same operational requirement as the Westland Weasel, and in earliest prototype form, like the original Snipe, had single-bay small span wings. In the absence of a Dragonfly engine it had a 200 hp Clerget. (*G. Quick.*)

Of similar specification to the Weasel was the private venture Sopwith 2F.R.2 Bulldog, though it went through similar metamorphosis to the Snipe, of which it was virtually a two-seat version weighing very little more. Originally with single-bay wings spanning some 30 ft, and then with two-bay wings of 33 ft 9 in span, it was an earlier starter than the Westland, and with the intended Dragonfly unavailable the prototype used a 200 hp eleven-cylinder Clerget. The pilot was located Dolphin fashion, hemmed in by cabane struts under an open centre-section, whereas in Bruce's design he was better placed farther aft beneath a cut-out in the trailing edge.

Inevitably the Sopwith hallmark of the Bulldog was unmistakable, with

The second prototype Sopwith Bulldog had larger two-bay wings of 33 ft 9 in span compared with 35 ft 6 in for the Weasel, but the Bulldog's smaller size necessitated placing the pilot in a questionable position beneath the centre-section. A third prototype had a Dragonfly engine on equal terms with the Weasel. (*G. Quick.*)

The new look in fighters emerged with the metal-structured Siddeley Siskin S.R.2 – the first entirely Siddeley-Deasy design though originated by Major Green at Farnborough. Not until the erratic Dragonfly engine was replaced by the Jaguar did this fighter prove acceptable. (*G. Quick.*)

its sound, light, but commonplace design. Westland revealed the same cautious path of sound development, so that their Weasel had similarity of line and detail with its predecessor, the Wagtail, though the new machine was somewhat influenced by the Bristol Fighter, designed by Bruce's pre-war friend and colleague Barnwell. Of much bolder conception was a third contender, the Austin Greyhound designed by John Kenworthy, who had played a leading part in the design of many Farnborough aeroplanes under the direction of Major F. M. Green. Clearly influenced by the R.E.9 on which he had worked, the Austin had affinity of line with the Siddeley R.T.1, employing a similar 'staggered décalage' as it was somewhat confusingly called when the top wing had greater chord and incidence than the lower, but in this instance it also had greater span. The tail surfaces and cranked skid with telescopic spring had the Factory pattern currently exemplified both in the R.T.1, and the new S.R.2 single-seat fighter, later called the Siskin, which Lloyd and Green were designing as a possible replacement for the S.E.5a. J. M. Bruce surmises that not only were S.E.6 drawings available as a basis for the new Siddeley fighter, but Green also had the preliminary layout of a proposed S.E.7 which he had sketched before leaving Farnborough. Not surprisingly all the ex-Farnborough designers used similar techniques, evident in the same tailskid arrangements which Folland now applied to the conventionally strutted, derived version of his first ill-fated Nieuport. Intended to surpass the Snipe when both were fitted with the Dragonfly, this Nieuport Nighthawk seemed a nice mixture of the best points of S.E. and Sopwith. There was renewed hope that the engine would prove effective, for special cylinders were being fitted of the type originated at Farnborough by A. H. Gibson and S. D. Heron before he left.

At Sopwith prototype after prototype was appearing, for the experimental department under Len Pollard was amazingly swift, whether

drastically modifying each new design or building in a few weeks yet another prototype of quite different conception. At the beginning of the year the Rhino triplane with 230 hp BHP had appeared in the rôle of a two-seat day-bomber. To give the pilot the best possible view he was located similarly to the Sopwith Spinning Jenny of 1915, immediately behind the engine, high in the turtle decking where he could see over the deep nose. Though the Rhino had the advantage of compactness, spanning 6 inches less than the 1½-Strutter day-bomber, its top speed of 103 mph at 10,000 ft was far too slow compared with 111·5 mph for the D.H.9 carrying two 230 lb bombs when powered by the same engine.

Surprisingly ugly for a Sopwith design was the two-seat 230 hp Rhino day-bomber of early 1918. The considerable depth of fuselage housed a hoist-operated rack of bombs and the pilot was located high above them with relatively good all-round view. (*Fleet Air Arm Museum.*)

Drag analysis still defeated designers. Indeed, there was very little information available on the parameters affecting performance. The Technical Department of the Air Board therefore requested the NPL to summarize all experimental data available from model tests so that wing characteristics could be predicted. This was undertaken by E. F. Relf, ARCSc, a round and merry little man, who collated and described, in what eventually became R & M 450, the aerodynamic corrections which must be applied to standard wind-tunnel model aerofoils of 6:1 aspect ratio having square wing-tips so that allowance could be made for curved tips of various form, different aspect ratio, biplane and triplane arrangements, and the effect of varying gap and stagger. He showed that the Reynolds number, which was the scale-speed effect, could be ignored if the test wing vl was greater than 25 in ft^2/sec, and model results could then be applied direct without great error. This 36-page compendium of Relf's was as significant and valuable as O'Gorman's great structural appraisal, R & M 127 of 1914.

Both at the NPL and the RAE much aerodynamic investigation was

being conducted at the specific request of various designers. Thus a complete D.H.10 model, with variable location of engines in the gap was tested to find the position of least resistance. With some surprise it was discovered that the popular mid-gap position hitherto favoured – as in the H.P. O/400, Avro Pike, D.H.3, Fairey F.2 bomber, and the flying-boats – was inferior to nacelles mounted direct on the lower wing. While there could be overriding reasons for a high inter-gap position, such as keeping flying-boat propellers clear of heavy spray, the lower wing location gave added benefit in the case of smaller twin-engined bombers by offering simplicity of installation and greater accessibility. The current D.H.10 and the equivalent Dragonfly-powered Boulton and Paul P.7 were too advanced to incorporate immediate rearrangement even though these Farnborough wind-tunnel tests had been endorsed by full-scale tests with the Avro 529A when in October of the previous year the BHP engines had been lowered and the cowling extended to join the top surface of the lower wing. Unfortunately the cause of the Avro's improved speed had been fogged by the usual bugbear of experimental work in so far that two changes had been made simultaneously, for power had been increased from two Rolls-Royce Falcons of 190 hp each to twin 230 hp BHPs.

As the result of wind-tunnel investigation the Avro 529A, with two 230 BHP engines, had the nacelles faired into the lower wing but the aerodynamic error was made of placing an interplane strut alongside it. (*A. R. Boeree.*)

Even more important than the increasing availability of practical aerodynamic information from the national establishments was the issue of a confidential booklet, H.B.806, from the Technical Department of the Air Board. Here, in order to ensure standardization of stressing, was full and clear explanation of the mathematical methods employed by the Department. Compiled by A. J. Sutton Pippard, MBE, MSc, AMICE, and Lieut J. Laurence Pritchard, RNVR, it was a valuable extension of the earlier leaflet written by Harold Bolas. To make the methods crystal clear, full stressing was given for a hypothetical aeroplane waggishly named the *Snag*. Much of the calculation had been carried out by the section of 'bluestockings' under leadership of Hilda Hudson, a Maths don from Newnham

College. Letitia Chitty, one of her staff, recorded in the Centenary Journal of the RAeS how she read maths at Newnham in the early years of the war, and then in August 1917 joined Miss Hudson's team, where Dorothy Chandler and Mary Hutchison were already established. 'There were also Miss Cave-Browne-Cave from Girton, and Miss Lang, devoted assistants to Leonard Bairstow. Commander Ogilvie was head of the department, and to begin with Capt A. P. Thurston was head of our particular section, with A. J. S. Pippard, J. L. Pritchard, Wilson and Howard as assistants. From Thurston I picked up valuable information for which I have always felt grateful. An engineer designer approaches his work visually to scale, and probably will not recognise his own particular ewe lamb in a free-hand "mathematical" sketch with the points of contraflexure marked in. These points of contraflexure were very important, as long lengths of Grade A spruce were getting rare and splices had to be placed at points of little bending. Professor Arthur Berry, author of that intriguing pamphlet on what to do when the end thrust becomes rather large, was also in the department, and in those days aeroplanes meant biplanes, with end thrusts due to stay wires. Calculations for the Sopwith triplane were still lying about, and the Camel was in the air. There was a sort of Army versus Navy atmosphere.

'There were no programmes, no calculating machines; we relied upon our slide rules and arithmetic in the margins, supported by the Theorem of Three Moments and Southwell's Curves for Struts. Each aeroplane, designed but not yet constructed, was received in the form of drawings and assigned to a pair of workers, the one to stress, the other to check the calculations. All that autumn, winter and the following spring we were busier and busier with new designs. Then in the summer came the awful lull with nothing whatever to do. The aeroplanes were all in production.'

If the hand-book had a fault it was lack of authoritative instruction on the Load Factors which should be used. Except for Farnborough's measurements of accelerations during manoeuvres there was no other information on safety margins. It was left to the designers' practical outlook to rationalize the conflicting requirements of light weight and great strength. One old-time designer said: 'We did it by guess and by God.'

In April the Grading Committee of the Aeronautical Society mellowed sufficiently to elect Hopkinson and Tizard as Associate Fellows, together with Frank Barnwell, Bob Blackburn, and Geoffrey de Havilland who at last were deemed experienced enough to represent the Trade, with Griffith Brewer as leading British Patent Agent, and Dr T. E. Stanton, Dr A. P. Thurston, W. R. Turnbull, and H. E. Wimperis representing the science of aeronautics.

8

The latest GHQ communiqué, like all others of that period, echoed the din of battle of the great German offensive. 'During the morning of 6 April, owing to bad weather, there was only slight aerial activity, but

about noon our machines, which had been watching the enemy's movements on the battle-front since dawn, reported a concentration of hostile troops south of the Somme. Large formations of our aeroplanes immediately went out in the rain and dropped over 500 bombs on the enemy's assembled infantry, in addition to firing some 50,000 rounds with machine-guns. In air fighting, twelve hostile machines were brought down and eleven others driven out of control. Sixteen of our machines have not yet been located. Throughout the present battle the Canadians and the Royal Air Force have done most valuable work.'

Only a few days earlier the communiqué had emphasized: 'During the last fortnight of intense fighting in the air, the assistance rendered by the personnel of the American Air Service attached to the Royal Air Force has been invaluable.'

To the dismay of many there was an undercurrent of bitter contention in the new Air Council. There were rumours and more rumours. It was said there was intrigue among the soldiers to get Lord Rothermere out. He was a sad man these days, for only recently his eldest son had been killed at the Front. *The Aeroplane* reported: 'There have been all the usual party cries that somebody must go. "Rothermere must go", because he cannot grasp the ideas or needs of aviators. "Henderson must go", because he is too closely connected with political people. "Norman must go", because he is too fond of interfering with the various interests, both civil and Service, of producers and users. "Trenchard must go", because he rides rough-shod over everybody else's ideas.'

It was Trenchard who went, for this great soldier held views as to the powers and duties of the Chief of the Air Staff which the Secretary of State of the Royal Air Force could not accept, as Major Baird explained to the House on 15 April following a Press announcement: 'His Majesty the King has been pleased to appoint Major-General F. H. Sykes, CMG, to be Chief of the Air Staff, Royal Air Force, on the resignation of Major-General Sir Hugh Trenchard, KCB, DSO.' Almost immediately Sir Godfrey Paine and Sir David Henderson tendered resignations. Many had forgotten that General Sykes, when a Captain, had been the first Commander of the Military Wing of the RFC, and in 1914 was Chief of Staff to General Henderson. Of late he had been Deputy Director of Organization at the War Office and a member of the Supreme War Council at Versailles where the Prime Ministers of Great Britain, France, and Italy regularly met. He was regarded as a secretive man – even though he inspired strong personal regard with many people, such as de Havilland – and it was known that his views and Henderson's were often antagonistic, so the fact that the latter had resigned certainly made it clear that Sykes's appointment was not made by General Henderson's political friends.

There were mixed feelings about Trenchard, for some regarded this tall, austere man as a Prussian Bismarck; yet he had made the old RFC the wonderful Corps it had become in recent years, and every pilot regarded him with veneration, confident that Trenchard alone could weld the

combination of RNAS and RFC into a harmonious and great fighting Service.

His friend and former commander, General Sir David Henderson, drew a veil across his feelings. He was the great inspired founder of it all – the gentleman soldier who disliked politics. He had suffered, too, over the muck-raking which Pemberton Billing and Joynson-Hicks had caused in Parliament, when they accused him by implication of being a murderer because under press of early circumstance he standardized the B.E.2c as the only aeroplane with adequate drawings for immediate and extensive production. Quietly he withdrew from his onerous tasks.

Ten days later Lord Rothermere resigned the post of Secretary of State for Air, and was succeeded by Sir William Weir. In his letter of resignation Rothermere said:

> April 25th 1918
>
> My dear Prime Minister, – I desire to relinquish my Office as Secretary of State of the Air Force at the earliest possible date.
>
> At times I have thought I would not be able to accompany the new Force so far. My second tragic loss in the war, ten weeks since, causes me great distress of mind and body. Every day the burden of work and responsibility seems crushing, and I am suffering from ill health. I felt, as I told you, that my urgent primary duty to the Government, and the Nation, required me to remain, if at all physically possible, until the date of fusion, and such time after as would suffice to establish the success of the amalgamation. My departure before might have gravely deranged what is now one of the nation's arms of war and have jeopardized the success of the whole scheme. I have entered into these particulars because I wish you to know the difficulties under which I have been working. I cannot close without expression of my great regard and respect. Yours very faithfully, Rothermere.

Said the caustic C. G. Grey: 'One is sincerely sorry for Lord Rothermere, this modern Samson Agonistes. He was ill-advised ever to tackle the job, and he was seemingly worse advised after he had taken it. There was little doubt that Mr George and his friends had made up their minds, very soon after the outburst of feeling over the upheaval at the Air Ministry became manifest, that Lord Rothermere was to be thrown to the lions. Possibly the sacrificial tendencies of Messrs George and Law were aggravated by knowledge that either they intended to quarrel also with Lord Northcliffe, or that Lord Northcliffe intended to quarrel with them; for it has since been consistently rumoured that Lord Northcliffe is resigning his post as chief propagandist in foreign parts. This would seem to portend war between the multiple alliance of the Harmsworth Press and the *double entente* of the Government. In the forthcoming campaign, the Fleet Street–Strand–Westminster front seems to turn on the inclusion of Lord Milner and Mr Austen Chamberlain, two honest and able gentlemen, in the Cabinet, and on prospective doings at the Air Ministry.

Throughout the war the F.E.2s plodded determinedly about their tasks. Nearly 2,000 F.E.2bs and some 400 F.E.2ds were built. This night-bomber version of the F.E.2b had a V-undercarriage and a 250 hp Rolls-Royce in quest of better performance.

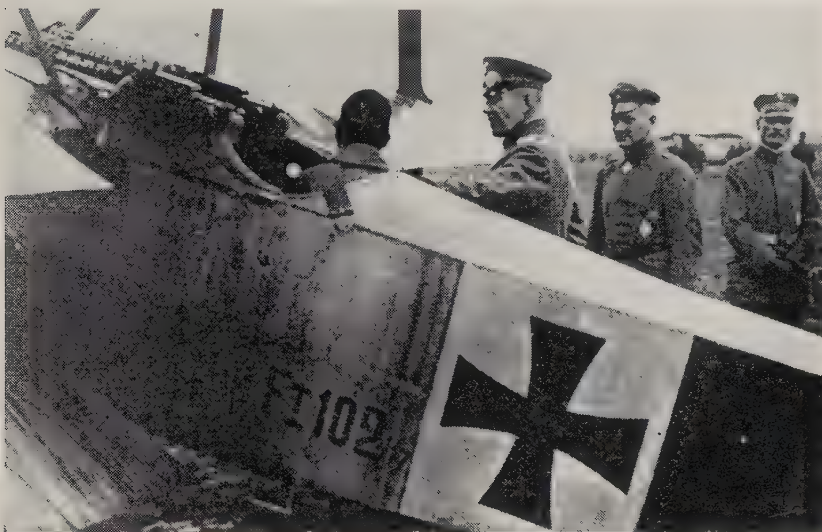
'The appointment of Sir William Weir to be Secretary of State for the Air Force seems to be one of the few good actions to the credit of this Government. Sir William has proved himself to be a great producer of *matériel.* It has been made known publicly, though it has long been known to many, that under his driving force the output of aircraft has overtaken and surpassed the output of pilots, and of the officers and men necessary to handle the machines on the ground.'

Indeed, production was in some ways like a runaway machine. Construction of B.E.s had at last ceased, but the F.E.2b and 2d had received fresh orders, and there was mounting production of R.E.8s. However, it was the D.H.9 which led the way, for 1,099 were built in the first quarter of 1918, closely followed by 1,069 Camels and 1,040 S.E.5s. Bristol Fighter production, as with the Sopwith Dolphin, was steadily climbing, but the Handley Page O/400 suffered a setback and only five were produced that quarter, giving a total of 46 including the experimental machines.

Engine figures for those three months showed almost 2,500 stationary water-cooled types had been produced – including 378 outclassed 160 hp Beardmores, which was 100 more than the 190 hp R-R Falcons. Only the huge purchase of over a thousand 200 hp Hispano-Suizas from France was saving S.E.5a supply from disaster. Meanwhile the 90 hp RAF and 80 hp Renault were churned out in great quantity, as well as low-powered rotaries for trainers; but the 150 hp B.R.1 was becoming established with 162 produced, though only ten B.R.2s had been built, and Camels must depend on the Clerget, which with 763 was second only to the 798 BHPs produced for the D.H.9. Even so it was necessary to obtain nearly 1,300 rotaries from France; throughout the war we had been dependent on their engine facilities to ever increasing extent. The grand total of engines obtained at home and abroad, that first quarter of 1918, was the highest ever at 8,260.

Word had gone round to the officers of the RAF that the debate in the Commons on 29 April would deal with the removal of General Trenchard. The gallery and seats for 'strangers' were crowded with personnel concerned in the future of the Service. Despite direct attack by many MPs

Lloyd George refused to discuss the reason for Trenchard's resignation but, in that hostile House, seemed ill at ease in endeavouring to shield Lord Rothermere. Nevertheless he announced he was glad to say there was every hope that General Trenchard's services would be retained in a position of considerable power in the Air Force. There was an audible sigh of relief. Even Asquith could draw no further information. 'Something has happened,' he said, 'which still remains undisclosed. Something has happened which convinced – who? – convinced Lord Rothermere that whatever other qualifications General Trenchard might possess, he was not the right man to be Chief of the Staff? I regard this as a regrettable incident, and one which I wish the Government could have avoided.'



Anthony Fokker in the cockpit of his first Dr.I triplane ready to hand over to General Falkenhayn (centre) for the personal use of von Richthofen (next right). Note shoulder-strap harness which preceded British use. (*A. R. Weyl.*)

Of great concern though this debate was to the Royal Air Force, the British public were far more interested in the report, a few days earlier, that the legendary 'Red Knight', Manfred von Richthofen, had at last met his end when flying his red Fokker triplane in pursuit of two Sopwith Camels. His fighters had appeared over the British lines between the Ancre and the Somme, not far from Corbie, at about 11 a.m. on 21 April, and attacked two aeroplanes, said to have been manned by Australians. Various British aeroplanes flew to their rescue, and a big dog-fight ensued, in which von Richthofen headed a Camel out of the fight, and was pursued in turn by another. The three were seen about two miles away from the general engagement, descending steeply until within 100 ft or so of the British trenches. Suddenly von Richthofen's triplane dived to the ground. Credit was given to Capt Roy Brown, the Camel leader – but the

Hermann Göring addresses the pilots of the Richthofen Geschwader to which he was appointed Commander on 5 July, 1918, after the death in a crash of Richthofen's nominated successor Reinhard. (*A. R. Weyl.*)

Germans explained that Richthofen had received a chance hit from the ground, and the Australian official history claims he was shot by their guns. He was buried the following day, six RAF officers acting as bearers, his coffin surmounted with a wreath bearing the inscription: 'A valiant and worthy foe.' He had brought down 80 British and French aircraft. Succeeding him came Wilhelm Reinhard, and then the persuasive but iron-willed Hermann Göring, who had 20 confirmed victories to his credit: had he not been a great and brave leader he could not have been chosen to uphold so imperious a tradition.

9

Though British aircraft production had swept to an all-time high, our American Allies were still in grave difficulty. The Senate Committee on Military Affairs submitted a report on 10 April which was hopeful, though not very informative, stating there was no cause for alarm over primary tuition aircraft because 3,458 had been completed, together with 342 for advanced training. However, 'the production of combat planes has thus far been a substantial failure, and constitutes a most serious disappointment in our war preparations. We had no designs of our own; neither did we adapt any one of the European designs until months after we entered the war. Much time was consumed in discussion as to type. Innumerable changes in designs and specifications of the types finally decided upon have cost further delay. In all, five types have been adopted, but two have been abandoned after expenditure of much time and money.' It was now revealed that in addition to the D.H.4, the Handley Page O/400 and the Bristol Fighter had been selected, similarly powered with the Liberty. But of the 22,500 engines ordered, only 122 had been completed for the Army and 142 for the Navy. 'Production to date is of course gravely dis-

appointing,' continued the report. 'Experts of highest reputation and experience have, since last July, repeatedly warned officials of our Government that the perfecting of a newly designed motor must inevitably involve months of painstaking experiment accompanied by many set-backs and disappointments. In spite of the unanimous testimony of motor experts along this line, government officials in charge of manufacture of the Liberty have made the mistake of leading the public and the Allies into belief that many thousands will be completed in the spring of 1918. Information of this sort, not borne out by facts, has been injurious, and its constant dissemination the Committee regards as misleading and detrimental to our cause.'

It was the old, old story.

A minority took a more defensive view, pointing out that when the war began the USA had purchased less than 200 aeroplanes in its entire history, and no American factory had ever made more than five or six a month. Few people grasped the magnitude of factories contracting to make 71,500 combat aircraft, of which each might have 4,000 parts and require 1,800 to 2,000 different drawings. Not only had factories to be established for the production of a hitherto unknown range of special aeronautical equipment but raw materials must be produced in quantity far exceeding all previous demand. The latter were the special responsibility of the Royal Signal Corps who, in addition to their huge forestry task, tackled such diverse items as planting 110,000 acres of castor beans for lubricating oil production and established distilling plants for the acetone required in dope for fabrics.

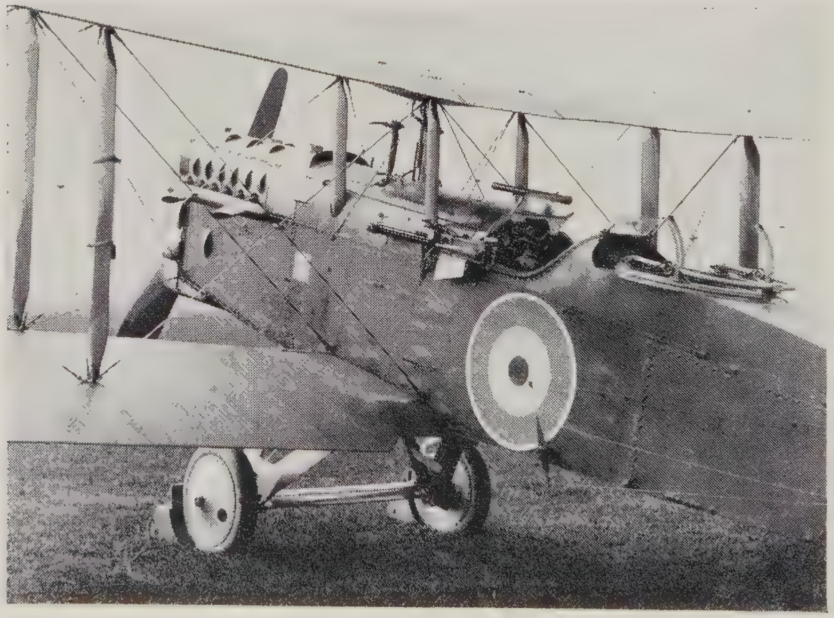
As a corollary of muddle and delay it followed that on 24 April John D. Ryan, an Irishman who had become a copper magnate, was appointed Director of US Aircraft Production, with Brig-Gen William Kenley Yeading as Chief Administrator of the Aeronautics Division.

In Britain Sir Arthur Duckham, KCB, as member of the Munitions Council, was appointed to superintend the Department of Aircraft Production in succession to Sir William Weir. He was senior partner in the firm of Duckham and Cloudesley Ltd, consulting gas engineers. Perhaps it was a prerequisite of government-appointed Controllers that they need have no knowledge of the subject on which they were engaged, for Sir Arthur was quite unfamiliar with aircraft; nevertheless, he was a go-getter who had been knighted in 1917 for valuable work in organizing production of munitions. To afford proper technical background, Alan E. L. Chorlton, CBE, was made Assistant Controller dealing more specifically with aero-engine supply excluding Rolls-Royce. Established with qualifications in civil, mechanical, and electrical engineering, he was chief engineer of Ruston, Proctor and Co with responsibility for their big output of engines and aeroplanes. To most people such changes seemed another routine reshuffle, but the surprise announcement that Maj-Gen Sir Hugh Trenchard had accepted Command of a new and very important part of the British Air Force was quite another matter. There could be no

question that he would replace Maj-Gen Salmond, who had revealed himself as a splendid G.O.C. in the Field. Rumour had it that Trenchard would organize an Independent Air Force for relentless bombing of industrial and military munition areas and factories in Germany. It was an historic expression of independence, for Trenchard was given a free hand, in general terms, to conduct his air war without subordination to Army or Navy Commands – though Salmond's Royal Air Force in France was still directly under the Commander-in-Chief of the Army, Sir Douglas Haig.

Despite the efforts of the SBAC, the entire aircraft industry remained unable to get its financial house in order. At the annual general meeting of Rolls-Royce Ltd, Ernest Claremont, the chairman, commented: 'So far during the war our profits have been small, compared with peacetime, and we have had no excess profits to pay. Delay in completing the balance sheet is due to our inability to fix the values of buildings and plant, provided solely for the purpose of the war. However we foresee that profits will not be less than last year, and so conclude that the same dividend can be safely declared, and the directors are recommending distribution of bonus shares, "share for share". Increase of nominal capital to allow creation of bonus shares amounts to £200,000 added to our existing capital of £200,000.'

Vickers, as manufacturers of engines and constructors of aircraft, were



This Westland-built D.H.9A is ready for despatch, complete with Vickers gun and Aldis gun sight, with a small windscreen installed to shield the observer. Total D.H.9A production from all contractors by the end of June 1918 was only 18, but in the next three months 288 were completed. By the end of the year 885 had been accepted. No. 110 Squadron in August was the first to operate D.H.9A's in France.

in worse plights, and explained to their shareholders: 'Owing to the fact that no settlement of this company's accounts has yet been come to with the Government, the directors regret it is still impossible to submit any accounts to the shareholders for the years 1915 and 1916 and now for the year 1917. We have good reason to hope that accounts for 1915 will soon be completed, but those for 1916 and 1917 must still be delayed if only for the reason that, owing to the immense mass of work flowing through, it has been impossible to arrive at definite prices with the Government for many of the contracts placed with the company.'

It was indicative of confidence that the war must soon end in favour of the Allies that recently both Holt Thomas and Handley Page had separately discussed post-war plans in public, and their views seemed endorsed by Vickers' directors, who stated at their shareholders meeting that they had been giving attention to post-war production and various plans for utilizing as much as possible of their war plant for peaceful purposes. They envisaged a comprehensive programme, but it would cost a considerable sum both to get into peace-time business and carry requisite stocks; for that reason conservation of capital was necessary.

This heel-dragging in presenting balance sheets was soon justified. The anomaly of profits had become too clear to be ignored, for the fledgling aircraft firms had been legally entitled only to 6 per cent on their extremely small capital, while the Government had 60 or 80 per cent, according to the year, of whatever was left. Thus the Government might take say £8,000 from one of the pioneering aircraft companies, leaving it only £2,000 profit, whereas a big firm long established in other allied trades might make £100,000 through building that same pioneer firm's aircraft, and could retain all of it. It was here that the SBAC substantially fulfilled its original purpose, for they had laid the whole question before the Board of Referees, and now an order was officially issued stating:

AIRCRAFT MANUFACTURERS
ORDER OF THE BOARD OF REFEREES
No. of Case 149

The Society of British Aircraft Constructors Limited, whose registered office is at 1 Albemarle Street, in the County of London, W.1., having made application under section 42(1) of the Finance (No. 2) Act 1915 (hereinafter called 'The Principal Act') to the Commissioners of Inland Revenue for an increase of the statutory percentages as respects the class of trade or business hereunder defined, that is to say:

> 'The business of manufacturing Aircraft (including both heavier-than-air and lighter-than-air) and/or Aircraft propellers.'

The Board doth order that as from the commencement of The Principal Act the statutory percentages as respects the class of trade or business herein before defined shall be increased:

1. In the case of any trade or business carried on or owned by a company or other body corporate to 15 per cent;

2. In the case of any other trade or business:

(*a*) For accounting periods ending prior to the first day of January 1917, to 15 per cent plus 1 per cent.

(*b*) For accounting periods ending after the thirty-first day of December 1916, to 15 per cent, plus 2 per cent; except that for the purpose of sub-section (2) of section 41 of The Principal Act the statutory percentage shall be 15 per cent plus 1 per cent.

With the addition, in cases 1 and 2(*b*) for accounting periods ending after the thirty-first day of December 1916 of 3 per cent for the purpose of sub-section (1) of section 41, of, and paragraph 4 of part II of the fourth schedule to The Principal Act. (Signed) D. M. Kerly, Chairman; J. K. F. Cleave; D. du B. Davison (Joint Registrars)

After allowing for such deductions, aircraft manufacturers found themselves entitled to 20 per cent of what was left. With the natural ability of this ebullient industry to bury its profits in plant, equipment, and expenses, it seemed that everyone would now be reasonably satisfied. Certainly an unfair but apparently accidental discrimination had been erased.

CHAPTER VIII

FROM WAR TO PEACE
1918 (*cont.*)

> 'And when they went, I heard the noise of their wings, like the noise of great waters, as the voice of the Almighty, the voice of speech, as the noise of an host: when they stood they let down their wings. And there was a voice from the firmament that was over their heads, when they stood, and had let down their wings'.
>
> Ezekiel (597 B.C.)

1

THE DRONE of an aeroplane might be heard at any hour these days whether one lived in Britain's quiet countryside or busy town. Rarely did people bother to look up at a distant Avro 504 or a Bristol Fighter purposefully drawing across the sky. Romance had not gone, but it had become commonplace as aeroplanes developed in lethal purpose. And in France and Flanders, above the tattered, shell-torn, ravaged lands they flew in hordes like hornets – sometimes almost out of sight; more often appearing with startling suddenness, thundering low and solitary, guns spitting viciously at German trenches. Everywhere they were playing havoc with Ludendorff's carefully planned offensive, racing low and far behind the German lines to mow down hundred upon hundred troops and destroy squadrons of great horses which were vital to the movement of field guns and transport. Others covered the slow withdrawal of British soldiers and their artillery, holding the advancing Germans at bay. The Camels, S.E.5s, Dolphins, and Bristol Fighters all unknowingly were turning the tide of war.

Early April seemed to indicate slackening of the German attack on the French and British lines, though already it had done immense damage. Vital railway communications were cut; Albert and Montdidier had been captured; Amiens, with its splendid Gothic cathedral, considered the greatest in France, was within gun range. Helped by incessant machine-gunning and bombing from our aircraft, the British Army was re-entrenching, and the line beginning to hold. The new Allied overall commander, Marshal Foch, was being given full credit by the French for changing the tide of war, but most people in Britain were dismayed that supreme control had not been reposed with General Sir Douglas Haig.

In the brief lull that followed, a new manpower Bill was hastily passed, increasing conscription age to 50 and withdrawing exemption from all young men. Meanwhile the vast army of men and women employed on munitions were urged to make good the tremendous losses of the first five weeks of the German offensive, when nearly 1,000 big guns and 4,500 machine-guns were captured or destroyed by the enemy, let alone thousands of rifles and a tremendous tonnage of small arms ammunition and shell. By now the so-called 'dilution of labour' had been more than justified, for nine-tenths of the entire shell production was the work of women who previously had never seen a lathe.

But on 9 April, with yet another thick and misty morning and again with no warning bombardment, the Germans attacked just south of Ypres where they savagely drove a salient of 3½ miles, and then with the aid of gas shells caused Armentières and Balleul to be evacuated while they pressed once more towards Amiens. Haig had retaliated over the appointment of Foch with the statement that Lloyd George had misled him both over the recruitment of men and the number available in France. On 9 April the Prime Minister waved away the charge when he ambiguously declared to the Commons: 'The army in France was considerably stronger on January 1st, 1918, than on January 1st, 1917.' His statement was received with incredulity, and Sir Godfrey Baring probed further by asking the number of operative troops in France on those dates. On 18 April the Parliamentary Under-Secretary for War, Ian Macpherson, affirmed there were more *combatant* troops in France on 1 January than at the same time last year. But he was wrong. That same day Lloyd George virtually dismissed Lord Derby as Secretary of State for War, and replaced him with Lord Milner on whom he could count for support against Haig if need be.

St George's Day on 23 April brought heartening news not only that several divisions of French Reserves were coming to support the British, but infinitely more stimulating was a great story of the Navy raiding Zeebrugge. HMS *Vindictive* had steamed in with dignified recklessness and lain alongside the Mole – and her sailors, with gallantry and dash of old, surged ashore, fighting the Germans hand to hand, while vessels were sunk across the greater part of the entrance to the great pen where the U-boats lay harboured. Thick slabs of concrete roofed the submarines, and even a particularly violent raid by Allied aeroplanes a few mornings earlier had failed to hit them. But now their teeth seemed drawn. It lessened Germany's hope of extending undersea warfare to strengthen her great attack by land.

To pay for the colossal war effort, Budget Day in Britain caused all who paid tax to gasp, for it put Revenue at the hitherto unimaginable figure of £842 million, and called for Income Tax at 6s, with 30s a gallon on spirits and, to the horror of the working man, 50s a barrel was imposed on beer. Prices everywhere had risen. The public growled that it was because of the salaries of the Government's huge war-time departments; they could only hope peace would restore the old conditions of low cost. Few except

bankers could see this was illusion and that nothing could recover the money poured away in destruction of the very things for which it had been used – cartridges, shells, bombs, ships of war, aeroplanes.

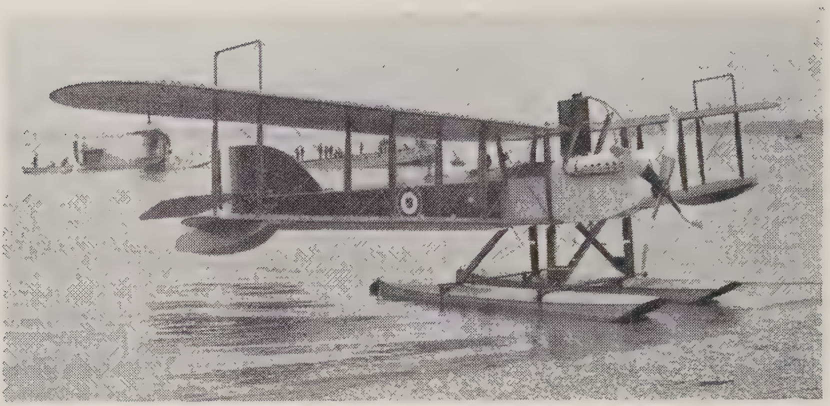
In Germany conditions were far worse. The *Morning Post* Special Correspondent, writing from the French Front on 19 April, reported: 'German aviation, a Staff officer told me, does not exist, the principal reason being *la casse* – in other words, the tremendous wastage caused in incessant attacks on enemy aeroplanes by British and French pilots. Germany today suffers from lack both of men and machines, and has taken the desperate step of calling up men from munition works to put into the lines. From the way in which she has thrown her divisions into battle, it is obvious that she believes she is playing her trump card. We have seen that she has been, and still is, exerting her full strength, and if she had aeroplanes available there is no doubt that she would have made full use of them, as we have done, for observation purposes, to prevent us bringing up reinforcements, and to disorganize our troops on the actual field of battle. She has done none of these things effectively. The conclusion seems manifest that it is because she has not the necessary force available.'

On 30 May, in a last great attempt, the Germans reached the Marne. Soon the papers announced the defeat of a heavy German attack which was pressing towards Ypres. The new Allied line was holding firm.

2

Though sporadic strikes were still breaking out in the British aircraft industry, the tremendous production was relatively undisturbed. Administrative posts were being strengthened, and W. A. Robinson, CB, CBE, was appointed Permanent Secretary to the Air Council. There were many changes of senior personnel among the manufacturers of aeroplanes and aero-engines. One of particular interest was the appointment of Wing Commander Gerald Aldwell as general manager of the Aviation

Known as the 'Converted' Seaplane, the big Wight had two long boat-built floats with bottoms employing Wight's three characteristic steps. The ailerons were double acting instead of single acting and the pylons altered to take the additional load. (*H. Busteed.*)



Rolls-Royce powered Wight Seaplane with Curtiss H.12 in background. (*H. Busteed.*)

Department of J. Samuel White at Cowes. He had been one of the first Naval Engineer officers seconded for aviation duties in the Navy, gaining his pilot's certificate on a Short as early as September 1913, but six months later was badly injured in a crash from which he never completely recovered. Though he had turned to technical ground duties, first with valuable pioneering work at Grain and then abroad, his health broke down and latterly he was invalided from the Service. At East Cowes he was now in charge of considerable production of the Wight single-engined bomber in the form of a twin-float seaplane, and the shops were also busy with Short 184s fitted with Sunbeam Maori like the Wight. Marcus Manton, the pre-war looping partner of B. C. Hucks, had recently completed trials of a modified version of Howard Wright's final design before leaving Samuel Whites in 1916 – a diminutive 19 ft span quadruplane which was now more effectively braced and had a much larger tail. Using

The Wight quadruplane prototype was in trouble with side areas, and the interplane struts were eventually left open and a larger fin and rudder fitted. Its test pilot, Marcus Manton, recorded that it finally crashed in a cemetery.

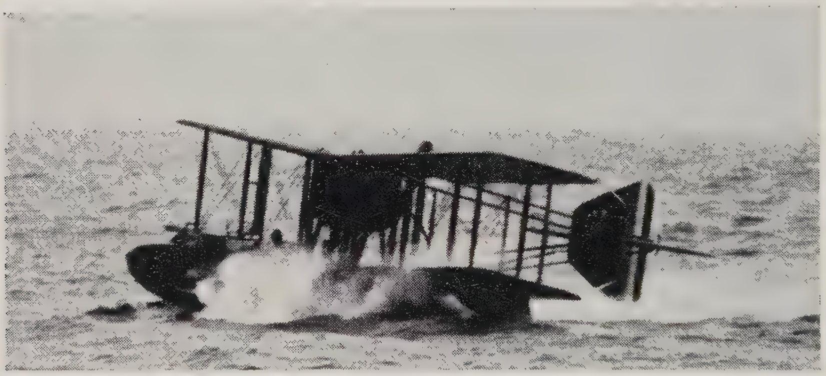
this experience, a small triplane flying-boat was being designed by T. C. Letcher under Aldwell's direction.

On the opposite side of the Solent, Gosport Aviation was busy with initial production of Porte's twin-engined Felixstowe F.5 flying-boat. It was an order on which Charles Nicholson based high hope of consolidating his new company, for Porte had already indicated his willingness to manage the business after the war, bringing with him the British rights to the master flying-boat patent recently granted to his friend and sponsor Glenn Curtiss in the USA. As late as 19 February, 1918, claims had been accepted of an application which Curtiss filed far back in December 1914. They comprehensively covered what had now become contemporary flying-boat design, but were particularly applicable to hulls having approximately elliptical section with 'one or both sides cut off to form the bottom of the boat, or the top thereof. The bottom of the boat is stepped, and the front portion is of vee section. Projecting laterally from the sides of the flotation body at or near the chine lines are elongated excrescence structures of approximately streamlined form. These are located in the vicinity of the resultant centre of hydroplane lift thus providing for quick rise from a submerged position at rest to a hydroplaning position upon the surface of the water at speed.'

Production F.B.A. No. 9630 of the Royal Naval Air Service. (*Imperial War Museum.*)

In the William Froude tank at the NPL work was being initiated by G. S. Baker, the master-mind behind hydrodynamic techniques, to compare resistances and hydroplaning behaviour of Porte's F.3 and F.5, Manning's new P.5, and a Vickers version of the F.5, on the assumption that each weighed 12,000 lb and took off at 39 knots. Model runs indicated that the Felixstowe F.5 and the Vickers F.5 with chined rectangular section hulls were 12 per cent better at hump speed than the other two. The P.5, with Linton Hope chined circular hull, had the advantage of running without porpoising in smooth water up to take-off speed though it porpoised in disturbed water, but the F classes porpoised much earlier unless stabilized by applying forward or aft control loads. F.B.A. flying-boats had similar trouble, hopping about 3 ft high during take-off. Baker reported: 'If it could be stated with certainty that tank results were reliable, a certain

amount of experimental work performed at air-stations could be done with greater ease and considerable saving of time and money in the tank. Our great difficulty is the absence of scientific data and the contradictory character of the *opinions* expressed by pilots.' His suggestion that comparative trials be made with one of the F.5 boats met with no success, but it was agreed that the unwanted experimental tail-boomed C.E.1 designed by Capt W. S. 'Bill' Farren of the RAE should be allocated to the Isle of Grain. It was soon found that model and machine were in fair agreement, and it became possible to explore both porpoising and hump speed resistance with greater precision, as well as general water resistance at various speeds when towed by a torpedo-boat destroyer.



The Royal Aircraft Establishment's C.E.1 was initially flown by its designer Capt W. S. Farren in January 1918, and later used for correlation with NPL model results. The wings could be folded at the outrigger joint on a diagonal hinge line. (*T. Elsemore.*)

Said Baker: 'Although the trials have been carried out under considerable material difficulties, and limited to what could be done with existing gear and apparatus, the results are of considerable value. They show that the predicted resistance from model results up to about half flying speed, and corresponding running angles, are reasonably close to those obtained in practice. They show that change-over from ploughing to planing takes place at "corresponding speeds", and that full-scale general behaviour is the same as predicted from the model. Before accepting these conclusions as widely applicable, it would be well to repeat experiments on another and different type of machine, but it is worth considering that all proposed full-scale experimental work should in future be "weeded out" at the tank. In any case it would lead to considerable saving if Experimental Establishments and the tank were each conversant with the work in hand and contemplated by the other – which is not the case at the present time.'

Yet it was not so much the gulf between practical operating men and investigating scientists that was primarily the trouble, but rather the inability of untechnical civil servants and Service officers who placed contracts and controlled expenditure yet failed to comprehend the essential link between research and practical results. Few among the scientific and

technical advisers of the Government had more than superficial acquaintance with the steady advance of that imaginative probability by which all industrial aircraft designers were constantly envisaging the future, based on their own intimate daily knowledge of step by step developments. But Baker had proved his point. Tank tests were requested for hulls of still bigger machines, of 32,000 lb displacement, known as the N.4 type, designed respectively by Linton Hope in conjunction with Fairey, and a rival inspired by Porte which the Gosport company were designing.

Flying-boat sizes apparently were going to exceed the huge four-engined V/1500 bomber which Handley Page had just completed at Cricklewood. This Super-Giant, as it was called by the workmen, was based on a modified O/400, C9713, which had been fitted with wings of equal span and, instead of horn-balanced ailerons on the top wing, had top and bottom ailerons with triangular inset tip balances operated through a conventional lever and pulley system. Because in the early stages it was not known whether to use twin engines or four in tandem, or even disposed laterally each side, the V/1500 wing design proceeded regardless of the ultimate engine arrangement. Said 'Star' Richards: 'We were driven like slaves. Every day we were taken to the office in Lord Londonderry's orange-coloured car from our lodgings to Queen's Island. H.P. only let us have Sunday afternoon off. Harland and Wolff had a tremendous number of carpenters available who normally would be used on the internal *décor* of a ship, and they made swift progress.' H.P. had stage-managed each step of the design. His unending theme was lightness with strength, and it was his forceful inspiration which led Scotland's leading mast-maker, McGruer, to develop circular spruce longerons and struts of circumferentially rolled spruce laminae. H.P. also obtained Patent 139,527 for silver spruce box spars and compression struts locally stiffened by laminae tapered from either side of the load point. Patent 140,113 described the method of attaching fittings by tubular bushes passing through the neutral axis of the spar. So new was the idea of a gunner in the extreme tail that Handley Page was able to patent this position.

Of special significance was his Patent 139,984 indicating concern whether the V/1500's range of action would be sufficient for Berlin to be bombed and safe return made to England. At first it seemed impossible, and the RAF agreed it acceptable for the machine to land either in neutral country or preferably on the sea – to which end the engine nacelles housed landing-wheels 'detachably connected to the aircraft' to lessen danger of tipping over if alighting on water.

Despite the colossal undertaking of this bomber project, it was accomplished in six months, and the first machine was ready for flight in May 1918, built from components manufactured in great secrecy by Harland and Wolff who had received a contract for 20 further machines on 27 January, 1918. More were ordered from the designers and others from William Beardmore & Co of Dalmuir.

When the wings of the prototype were folded for the first time it was

Preparing the prototype Handley Page V/1500 for initial flight. The large single radiator can be seen in front of the centre-section struts. The engines were uncowled and the ailerons had inset horn balances. (*J. W. R. Taylor*)

found on the following day that their weight locked to the fuselage had caused the vertical fuselage struts to bow outwards, aided by an offset of the transverse bracing eye-bolt; but instead of strengthening the strut system, H.P. exhibited his characteristic unflurried solution by fitting a transverse tension wire linking the bowed struts.

All first flights are a tense occasion to the designers and builders of any prototype aeroplane, particularly of something so huge as the V/1500 on which such high hope was centred. Pilots seem less concerned.

Capt Vernon E. G. Busby, now more experienced in test flying H.P. twins than any other pilot, made the initial test towards the end of May with Jack Hathaway and apprentice Francis Kappey as crew. Describing the occasion, Kappey told me that on leaving school in 1915 he had briefly joined Grahame-Whites and then was indentured to Handley Page, but from early 1917 had been trying to join the RFC. 'Thus though on the Reserve, I was still at H.P.s and worried all concerned until I was allowed to participate in the V/1500 flights. Busby was a tall and exceptionally agreeable type, who as a youth was a keen motor-cyclist. Hathaway was a gaunt and silent man who had been one of George Beatty's instructors when their school, together with Ruffy-Baumanns, was evicted from Hendon in 1917, and they then based it at H.P.'s Cricklewood aerodrome. By the time of the last flight I had joined the RAF but had taken part on all

To improve airflow the tandem engines of the Handley Page V/1500 were cowled. Stability problems led to the leading edges of the rudders being stripped of fabric in case the unshielded rudder balances were to blame. (*S. T. A. Richards.*)

the other test flights including one with full 1,000 gal in the fuselage tank and ballast to simulate the designed all-up weight. The irrepressible Sefton Brancker was co-pilot on one occasion.'

Busby found the ailerons very heavy, stability longitudinally marginal, and the machine hunted directionally. With earlier O/400 experience in mind, Handley Page had each rudder balance area halved by removing its leading-edge fabric, leaving the rib structure exposed; the ailerons were rebuilt with back-set hinges giving leading-edge balance instead of the original triangular horn, and their noses interconnected and operated through the leverage of tall kingposts on the top surface of the lower aileron and bottom surface of the upper to give greater mechanical advantage, and the system was granted Patent 140,113. Though the redesigned aileron control still required mechanical revision, lateral control was now better and reasonably suited to the inertia of the machine – but directional hunting remained unacceptable, even when a relatively large

In pursuit of improved directional behaviour for the V/1500 a fin was fitted above the top tailplane, rudder balance restored, and the tail gunner's cockpit given a tapering fairing. The modified ailerons can be seen. (*S. T. A. Richards.*)

rectangular fin was fitted above the upper tailplane and the fuselage extended rearward with a long pointed fairing that ruined the tail gunner's downward field of fire. At first the directional trouble was ascribed to adverse flow from the nacelles, but urgent wind-tunnel tests led to a redesigned biplane tail of greater gap, rudder hinge lines coincident with the rear spar instead of the front, and big fins with leading edges just clear of the tailplane front interplane struts.

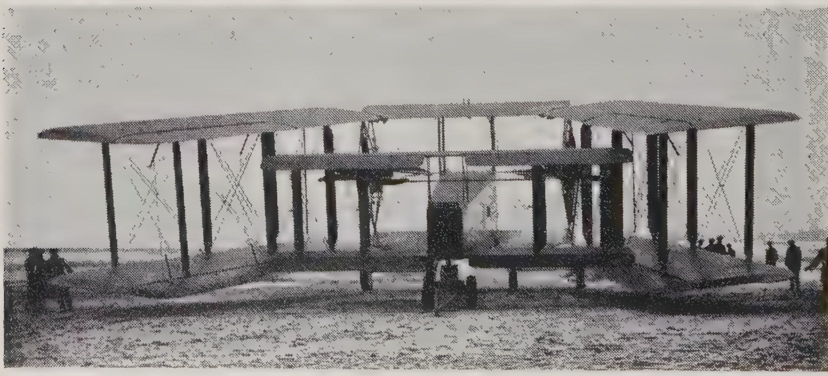
Using the identical wind-tunnel some years later, I was interested to find optimistic prediction of directional stability and pessimistic rudder hinge-moments, and this must have led Handley Page to give the V/1500 too short a fuselage lever arm for directional stability, though marginally

In final form the Handley Page V/1500 reverted to open engine cowlings, but had bigger tail gap and big fins. A small team acted as brake when folding the wings.

adequate for longitudinal damping. This kind of thing led to distrust of wind-tunnels, for it was not initially realized that scale effect necessitated empiric revaluation of recorded figures based on accumulating experience of full-scale results. To do so required a sequence of prototypes, whereas this was only the third of the Handley Page war designs.

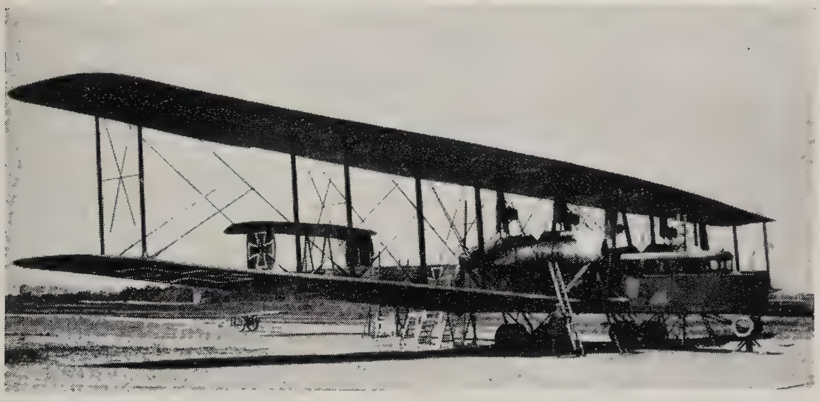
In June there was tragic set-back. Again flown by Busby, the machine took off on a routine flight with Hathaway as crew and four passengers. Suddenly it was observed in difficulties, and in attempting to land, stalled and crashed in the fields north-east of the aerodrome, bursting into flames. The sole survivor was the Air Board's official acceptance officer, Colonel Alec Ogilvie, that early Wright pilot, who was in the tail gunner's cockpit remote from the point of impact. There was no duplicate prototype, and although production had commenced, machines were only in the earliest phase of construction. Despite hurrying the next one forward it would clearly be impossible to continue development flights until autumn.

There was little consolation in the fact that an equivalent German four-engined biplane had just been captured on the French Front and showed



Rear view of the Handley Page V/1500 with wings folded. The designer's art was to secure clearance between tailplane and wings and ground.

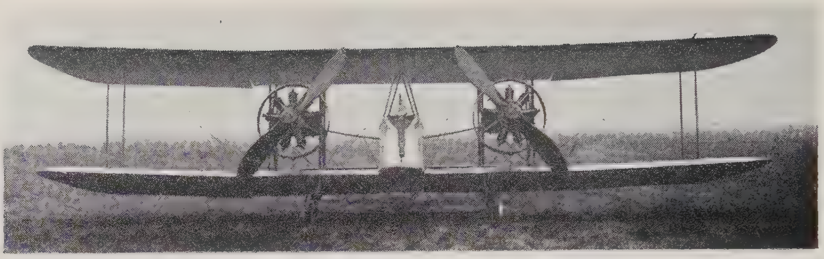
marked inferiority. It was not certain who had built it, but it appeared to be a product of the Zeppelin Werke Staaken constructed in the summer of 1917. Its span of 138 ft compared with 126 ft for the Handley Page V/1500, but technical investigation indicated such crude structural design in the interests of easy production that it would be unacceptable to British minds. Thus old-fashioned cable and piano-wire bracing was formed into continuous double loops which were not linked to fittings but passed diagonally round three faces of the wing spar, located only by a grooved cleat based on the centuries old method of rigging a sailing ship. The fuselage was cross-braced chiefly with 3-mm piano wire looped into simple flat sheet-steel fittings welded to the bottom of steel-tube fuselage spacing struts which



The Zeppelin Staaken R.VI with a span of 138 ft was 8 ft bigger than the Handley Page V/1500, and had an eight-wheel undercarriage. The tail was as big as a single-seat fighter. The type began raids on England on 17 September, 1917, so was well ahead of the V/1500. (*A. R. Weyl.*)

linked the substantial built-up box spar longerons. It had nothing of the Handley Page sophistication. A critic described this Staaken as an over-rated colossus, explaining: 'The Germans have only enlarged the dimensions of their big twin-engined machines without venturing into the unknown or into original thought. Their Zeppelin has hardly anything peculiar to itself except its enormousness. Working on what existed, they have never executed any prodigious step forward, but have, on the contrary, merely effected transitions.' That was the general safe practice of designers of all nations, though in fact the Germans were already far ahead in metal techniques, and there were rumours of a remarkably clean and fast all-metal cantilever-winged two-seat monoplane fighter that Professor Hugo Junkers had built after severing connection with Anthony Fokker, and which was being tried at one or two *Schlachtstaffeln*.

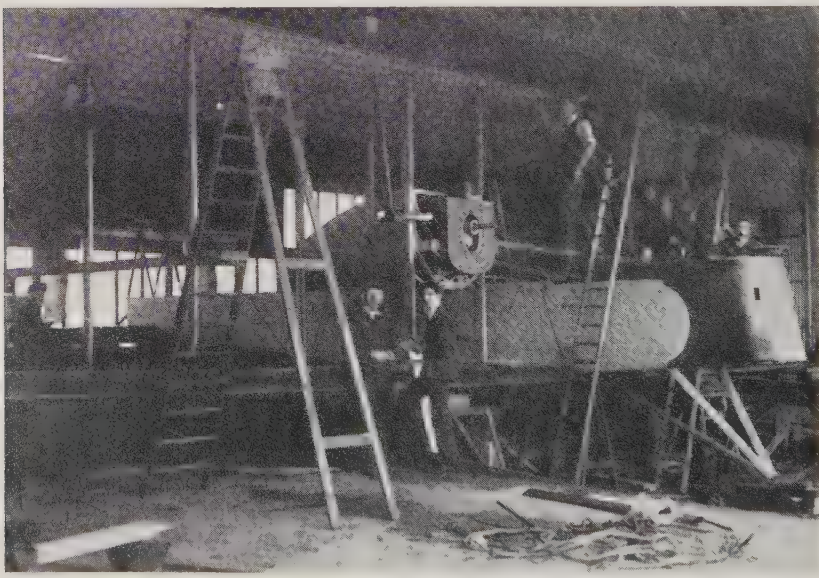
A month before the V/1500 had flown, the prototype Vickers F.B.27, later christened the Vimy, returned from Martlesham Heath where it had undergone official trials throughout the previous three months. Rex Pierson had every reason to be proud of his effort. 'It was our outstanding success of those times,' he wrote. 'We built it from scratch to first flight



The Vickers E.F.B.8 of 1915, although only 38 ft 4 in span, was an aerodynamic guide line to Pierson's Vimy of exactly two years later. Powered with Gnome Monosoupapes it had been the fastest twin-engined aeroplane of that year. (*Vickers Ltd.*)

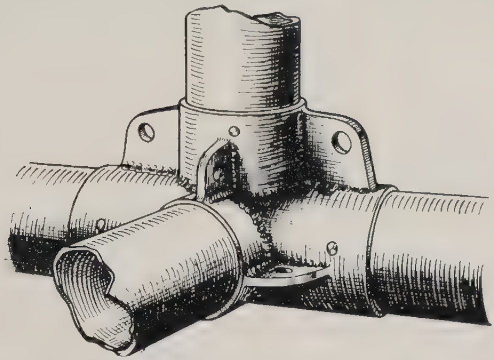
inside six months. It was the biggest design we had tackled and the swift completion of that first machine was a great credit to my staff.'

The F.B.27 had been tested by the flamboyantly dressy and stuttering Gordon Bell on the last day of November, construction having commenced in June 1917, Pierson recollected, and an order for three aircraft followed a month later. In appearance the prototype seemed an enlarged but natural outcome of the two previous twin-engined Flanders-Vickers biplanes of 1915. Structurally it had conventional equal-span three-bay wings of wooden construction – using a Vickers aerofoil section having small under-camber to give space for relatively deep spars – but the forward fuselage portion differed from contemporary British aircraft in being constructed



The new hope in bombers being completed at Joyce Green in November 1917 was the prototype Vickers F.B.27, powered by two 200 hp Hispano-Suiza engines with inverted radiators. Subsequently 260 hp Salmson radials were fitted to this machine. (*Vickers Ltd.*)

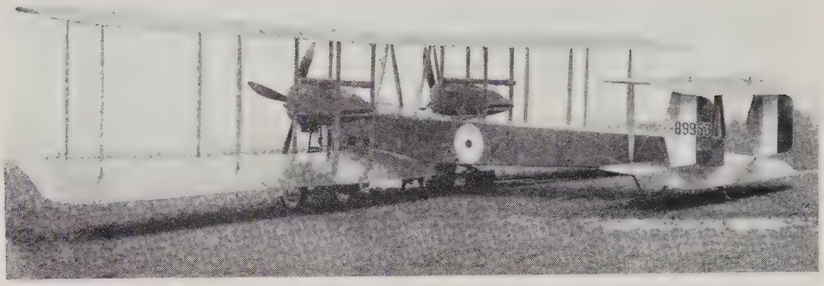
entirely from steel tubing, largely as a result of Pierson's early training with Low's derivative of the first Vickers R.E.P. monoplane. McGruer-fabricated wooden tubes were used for the rear half. Like the Handley Page O/400 and V/1500, the new Vickers had a biplane tail and independent two-wheel undercarriages beneath each engine bay. As a safeguard for night flying the F.B.27 had a stout hockeystick-shaped ash skid triangulated beneath the nose to prevent tipping over, for it was probable that the new bombers might operate from relatively unprepared, soft-surfaced, advance flying-fields.



Typical Vickers metal construction, inherited from A. R. Low's pre-war designs, is this simple built-up steel socket used for steel tubular structural members in the fuselage from nose to just abaft trailing edge of the F.B.27.

The prototype had been designed to take RAF 4d engines, but as they were not proved, two 200 hp Hispano-Suizas were installed somewhat far back in stumpy fully enclosed nacelles behind nose radiators which seemed upside down, but were possibly originated for direct-drive engines when the other way up. Unfortunately there was considerable engine trouble, due in part to the water system. Nevertheless Martlesham test pilots were pleased with the machine, particularly as it had lifted about one-third of a ton more than the big 275 hp R-R Handley Page O/400 – but it was conveniently overlooked that the Handley Page wing loading was some 2 lb/sq ft more than the Vickers because fuel capacity and range were three times greater.

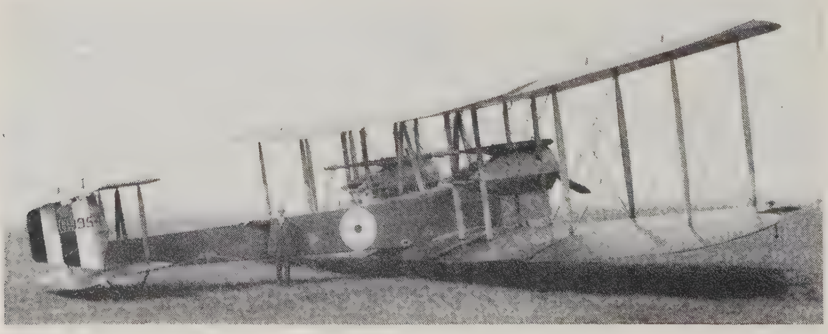
Currently the second Vimy prototype, powered with 260 hp Sunbeam Maori engines, was being tested by Gordon Bell at Joyce Green. It differed from the first in substituting inversely tapered ailerons together with unbalanced elevators and conventionally raked tailplane surfaces for the tip extended balances originally employed. There were minor structural changes, and rear defence was implemented with an additional lower gun abaft the wings which fired through an under-fuselage aperture as used in the Gothas, and thus eliminated the blind area beneath the tail where fighters usually attacked. Changes were made to the coolant system, and four-bladed propellers were fitted. After more modifications to improve cooling, Gordon Bell flew the new machine to Martlesham for further tests



Differing from the first prototype and later machines, the second, powered with Sunbeam Maoris, had markedly different wing-tips. General redesign had made the Vimy half a ton heavier. (*Vickers Ltd.*)

on 26 April, but it crashed on an early flight following engine failure, though not before proving that the rate of climb had increased.

A third machine was hurried forward, this time powered by two 300 hp Fiat A-12s having larger octagonal-shaped radiators with cooling shutters and appropriately shaped nacelles. A big single exhaust pipe was set to starboard above the top of each nacelle. A further distinctive change was the rearranged forward gunner's position, which now was given a vertical nose instead of backward rake, and three vertical transparent panels were inserted so that the gunner when lying down could see to aim, using an externally mounted bomb-sight. The machine was regarded as a considerable improvement except that the ailerons were so heavy they gave sluggish control. A new set of wings was therefore constructed with similar horn-balanced ailerons to the original – for, on the strength of the first machine's performance and handling, a contract had been placed on 26 March for an initial batch of 150 aircraft, and in May others were ordered from Clayton and Shuttleworth Ltd of Lincoln, Morgan & Co of Leighton Buzzard, Westland Aircraft Works at Yeovil, and the Royal Aircraft Establishment. A further 200 were envisaged from Vickers which



The third prototype Vimy had Fiat A-12 engines, but was even less lucky, for it stalled while taking off from Martlesham with a live bomb-load and exploded in flames. (*Vickers Ltd.*)

would be added to the first batch at their Crayford works, for Weybridge was wholly engaged on enormous production of the S.E.5a. Under Maxwell Muller's control the organization planned by Frank Hearle was proving so effective that more than 100 machines a month were being turned out. Before the war ended this would result in 1,650 S.E.5as – far exceeding all previous Vickers production comprising some 75 B.E.2cs; 100 of the original pusher F.B.5 Gunbus; 95 of its derivative F.B.9; 50 F.E.8s; 100 of the two-seat fighter reconnaissance F.B.14; and 65 of the F.B.19 single-seat fighter descended from Barnwell's E.S.1 and E.S.2, and used principally in the Middle East, with a few supplied to Russia.

Built to the same requirement as the Bristol Fighter, the prototype Vickers F.B.14 had a 160 hp Beardmore due to unavailability of the 230 hp BHP. One hundred and fifty were ordered, and alternative engines tried. Largely because of the long fin the machine was unspinnable. (*Vickers Ltd.*)

3

Despite air and naval attacks on submarine pens the U-boats were exacting tremendous toll, though more food-ships were getting through than expected. Before May was out the British mercantile cruiser *Moldavia* had been torpedoed and sunk, and the US transport *President Lincoln* met the same fate in European waters. In June HM Hospital Ship *Llandovery Castle*, homeward bound from Canada, was torpedoed and sunk with great loss of life. Many small merchant ships continued to be sunk indiscriminately. Nevertheless bacon and frozen meat supplies were getting through from the USA, and this enabled Labour's J. R. Clynes, who had recently been appointed Food Controller following ill-health of Lord Rhondda, to ameliorate meat rationing a little. But food was still scarce, and sugar almost unobtainable. Clynes assured the public that the submarine menace was passing, and soon there would be more food; yet this was regarded by manual workers merely as confirmation that profiteering

was the root of the trouble. Everything remained difficult. Rail travel was still drastically restricted, not only through shortage of coal for railways as well as households, but because so much rolling stock had been sent to France. Labour was unavailable for anything except national work, but what hit heavily was that the up-costed beer was weak because of restricted malt supplies, and tobacco not only dear but often impossible to get, and one had to hunt from shop to shop to find a box of matches. National temper was growing irritable, and there was widespread depression at mounting casualties in France.

The growing toll of air accidents in England seemed to emphasize the doom of youth in France. Some of the fatalities, whether at home or abroad, could well have been prevented. Major Raoul Lufbery, the great American ace, had recently met his fate during an engagement with an enemy aircraft, jumping from his machine at 2,500 ft when it became a roaring furnace. With parachutes he and many others might have been saved. It was not surprising that the possibility of using this safeguard was re-opened in the House, for in 1917 nearly 800 pilots had been killed while training in this country, let alone those on active service. When Major Baird replied that the great majority of accidents occurred in circumstances where a parachute could not be used, *The Aeroplane*'s well-briefed editor was quick to point out: 'There are many cases constantly occurring in which parachutes would save life, such as those in which tails or wings or controls break in the air, and especially cases of fire. Quite apart from the actual saving of life, the knowledge that such a form of lifebuoy existed on an aeroplane would save many a man's nerve for long periods. Parachutes and methods of fitting them exist. The only thing which hinders their use is the obstinacy of people in the Technical Department.'

Indeed, Ernest Calthrop was still vigorously advocating the value of his Guardian Angel for aeroplanes, and was developing improved release apparatus with the aid of Capt Arthur Payze, RAF, and a young engineer named Edwin Boyle. They were sufficiently near solution for Calthrop to apply for a patent (No. 135,884) which described 'a pilot parachute and a main parachute separately housed in compartments in the fuselage and arranged so that the compartments containing the pilot parachute may be opened to the air-stream, whereupon the pilot parachute is projected upwards and pulls out the main parachute. Means are provided also for depressing the tail of the machine to counteract a nose dive and to ensure that the aviator should be drawn clear of the tail by the parachute.'

In June the RAF Parachute Committee was formed, with the devil-may-care Major Orde-Lees as secretary. Maj-Generals Maitland, Brooke-Popham, and Longcroft were in favour of parachutes. Nevertheless technical problems remained considerable. Tentative tests with a D.H.4 carrying a Calthrop showed a reduction of 3 mph in speed and 50 ft per minute in climb, though accuracy of this order is doubtful. Only one officer, Sqn-Cdr Chalmers, ever suggested that parachutes should not have static line attachment to the aircraft, but his view was not accepted as it

was thought pilots would become unconscious if subjected to a free fall.

To try and bring home the importance of parachutes, Calthrop bought the original L & P training biplane of Tony Fletcher's 1916 design. Two parachutes were stowed in a section of the fuselage behind the rear cockpit, where the cross-bracing was removed and reinforcement fitted. The release was operated from the pilot's seat, and a 12-stone weight, representing a passenger, was mounted somewhat unconvincingly on the undercarriage. Members of the Air Council and Services were invited to witness a flight demonstration, and Capt Payze made a single circuit at 300 ft, then pulled the lever releasing the weight from its perch, which in turn pulled a parachute from its cylindrical pack and it immediately opened. Calthrop told his visitors that he had schemes to enable launching from any position the aeroplane might assume, and a prominent firm at Lloyds was offering to reduce premiums by 20 per cent for all pilots flying aeroplanes equipped with Guardian Angel parachutes. But the officials were not convinced.

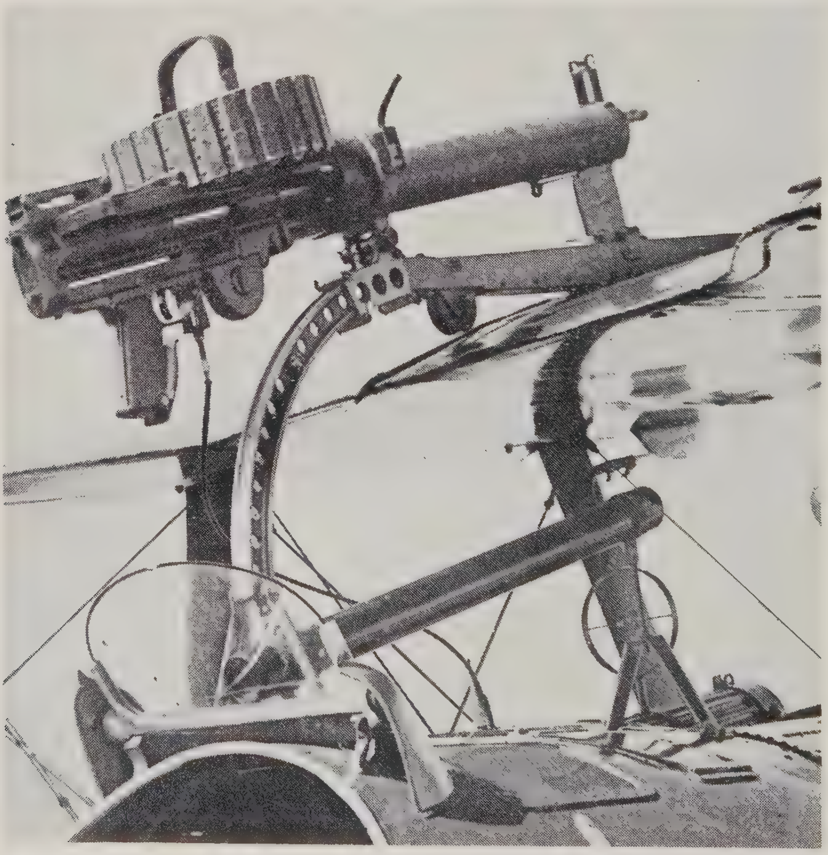
The long line of development from Barnwell's *Bullet* included the F.B.16 intended for the Hart engine but was rationalized into a Hispano-Suiza version, the F.B.16D, rival of the S.E.5, shown with Capt. J. T. B. McCudden in the cockpit. (*Courtesy C. F. Andrews.*)

A fortnight later it was announced that Major James ByfordMcCudden, VC, DSO, MC, MM, had been killed in France on the evening of 9 July. Promoted only the previous Saturday from Captain as a Flight Commander, to Major as a Squadron Commander, he was on his way to his new command in France, flying an S.E.5a – a type he described as one of the finest pieces of work ever seen, which was tribute indeed from a pilot with such exceptional mechanical skill.

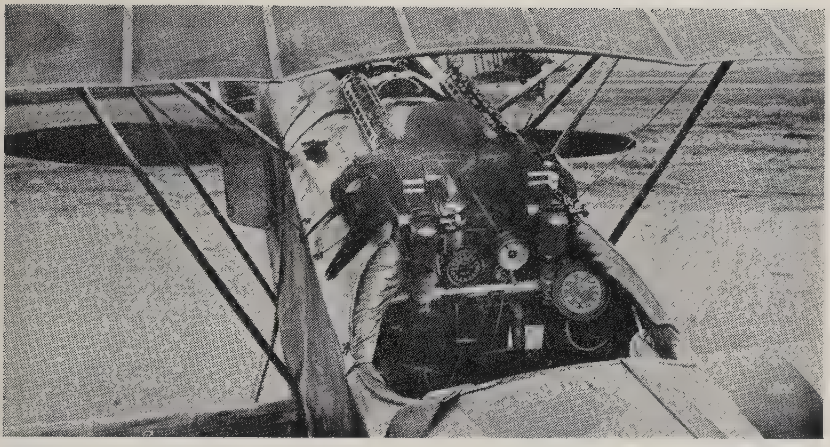
He had briefly landed to enquire the way at the small aerodrome of Aix-le-Château where No. 8 Squadron was established with three hangars and its 'Big-Ack' F.K.8 reconnaissance aircraft sheltered by the curve of a tall wood. Without stopping the engine McCudden took off again, turned

at about 700 ft and turned again as though in trouble. Onlookers heard his engine falter, and the S.E.5 plunged into the trees behind the hangars. They found McCudden mortally injured. One of the witnesses said: 'What went wrong may never be known, but one wonders whether, if he knew his machine was out of control, he might have been saved by a parachute, for it will be of interest to many that as the result of all his fighting and flying experience, Major McCudden was one of the strongest advocates of parachutes as a standard fitting for all aeroplanes, either on active service or at home.'

McCudden's career had been marked by success after success. Trained as a mechanic RE, he joined the RFC in May 1913, and when war broke out was a 2nd class Air-mechanic in C Flight of No. 3 Squadron at Netheravon, under Major Brooke-Popham. Not until 1915 did he become a Sergeant-pilot, flying single-seat pusher D.H.2s under the command of



The S.E.5a cockpit had the Lewis gun within reach on a Foster mounting, but in changing to a fresh drum there was always the risk that it would be blown away. Capt Ball, VC, dispensed with the usual fixed Vickers, and used a second downward-firing Lewis.



The Fokker D.VII followed the Fokker triplane theme of welded steel-tube fuselage and one-piece wooden cantilever wings. Unlike many British fighters, a movable top gun was never used, but reliance placed on twin fixed Spandau machine-guns accessibly placed to clear stoppages. (*A.R. Boeree.*)

Major Lanoe Hawker, VC, DSO, and it was then that he won the Military Medal and French Croix de Guerre. His mechanical aptitude was never discarded, and he always saw that his aeroplane, engine, and guns were in finest possible trim. As his obituary said: 'Above all he relied on careful study of his enemy's psychology, but he had no hatred for them. In fact he had the greatest admiration for German fighting pilots. Von Richthofen, Boelcke, and Voss were to him heroes worthy to rank with our own best – a view in which a majority of the RAF agree.' Both his brothers had been killed in the RFC – the elder in an accident while instructing with a Blériot at Gosport in 1915, and the younger as a fighter pilot in the recent Somme battle.

Within a few weeks, those who opposed provision of parachutes for pilots had their arguments strengthened by a sad fatality during experiments with the latest Calthrop, for Boyle, the company's young engineer, was killed while jumping from 400 ft. A dog-hook in the quick release jammed askew in a ring on the parachute case, causing the latter to fall with the unopened parachute still in it. Though Calthrop vigorously pursued other methods of release, our Service and civil technicians remained too sceptical for parachutes to be adopted for aeroplane pilots during the rest of the war. Concurrently *The Times* correspondent reported that: 'In the last three days two cases are reported of German airmen in Fokker biplanes, after being shot down by our men, escaping from the falling machines by parachute. Apparently the parachute, which seems to be made of white silk, and is smaller than a balloon parachute, opens automatically by air pressure as the machine rushes downwards and automatically pulls the airman out of his seat. In one case the parachute did not seem to begin to work until the machine had fallen at least 2,000 ft.'

At about this time the independently minded Capt W. O. Bentley was

quietly eased from further official participation in the brilliant line of engine development he had initiated, for he fell out with Lord Weir who, in his new capacity as Secretary of State for the Royal Air Force, had been elevated to the Peerage on 19 June. As Sir William Weir – a man in his middle thirties with hair already thin and fast receding, but a tremendously energetic and strong-willed personality – he had performed a great and difficult task in organizing the productive channels of aircraft and aero-engine manufacture, and in deciding what to standardize. But thanks to the skilful salesmanship of Granville Bradshaw, the A.B.C. designer, he had blundered in believing that the Dragonfly alone could give assured success not only to the vital 1919 range of single-seat fighters, but also to the two-seat fighters, reconnaissance aircraft, and twin-engined day-bombers during the last great struggle of what was already officially regarded as the final victory year for the Allies. On that gamble, the greater part of the British aircraft industry depended.

Lord Weir (left) created tremendous pressure to increase aircraft production but underestimated engine development time. Robert Blackburn who had responsibility for developing the Sopwith Cuckoo and was destined to play a major role in production of naval aircraft. (*Flight Photos.*)

Reports now reaching Lord Weir indicated that he had embarked on a course of disaster. He was immensely concerned. Pilots condemned the engine because it caught fire in the air on the least provocation; power was usually 40 to 50 hp down; the valve rocker-arm box on the cylinder head loosened and vibrated when hot to give erratic valve operation; maximum 'life' for the engine remained only 2½ hours. Twenty-eight-year-old Bentley was summoned to the presence and told to investigate the problems. He returned after witnessing engine tests and discussing matters with Farnborough, and reported that in his opinion the entire engine would have to be redesigned. Weir was furious. Brusquely he snapped: 'Bentley – you're obviously suffering from fatigue. I'll see that you are given a rest.' From that moment, Bentley was virtually dismissed – despite the fact that his B.R.1 had given the Camel a vital margin of superiority in air fighting, and but for his powerful B.R.2 there would be no immediate new generation of

fighters to maintain air supremacy. At least it was now clear that the A.B.C. Dragonfly was going to take years instead of months to develop.

Instead of going on leave, Bentley got the Navy to ferry him to France. Thereafter he unofficially went from squadron to squadron of Bentley-powered aircraft, his presence giving enormous confidence to the pilots and his absence from London diplomatically ignored.

Though the A.B.C. engine had proved so disappointing there were over 11,000 on order from 13 contractors, but production engines were proving heavier than the optimistic sales talk of 1·75 lb/hp and brake test endorsed the deficiencies in power. Although tentative research and mathematical treatment of its torsional crankshaft vibration was in hand, the complexity was not appreciated, for it seemed that the trouble could be no greater than the miscellany of snags affecting many other new engines such as the Jaguar, despite its Farnborough ancestry; the Cosmos Mercury; the big V-12 Siddeley Tiger in the 600 hp class for which Rolls-Royce were competing with the Condor; and the BHP Atlantic which the Galloway Engineering Co were producing to Halford's design. Of these, Rolls-Royce were proceeding with the usual slow thoroughness of their developments, and the Tiger and Atlantic were beset with major difficulties, achieving less than 500 hp. Even the Puma was still far from right, but its fuel economy gave the D.H.9 the advantage of greater bombing range than any other aircraft including the O/400.

4

July saw more trouble with munition workers, partly because of a comb-out in an effort to extract the last drop of recruitment yet still leave a fair share of skilled men. Workers at Coventry immediately struck. Strikes spread to Birmingham, Manchester, and Lincoln, and there were threats all over London. Trade unions lost control. Shop stewards were ignored. It was like a conflagration. The Government took the only step possible, and proclaimed that every worker absent, other than through illness or other proper reason, would be deemed to have voluntarily left the exempted industries and would be called up for the Army. It had immediate effect.

Sir L. Worthington Evans, Parliamentary Under-Secretary to the Ministry of Munitions, resigned, and Maj-Gen the Rt Hon J. E. B. Seely, CB, DSO, MP, on returning from Active Service was appointed Deputy Minister of Munitions, with special duties on the Council for the Warfare Group. Said the *Morning Post*: 'That General J. E. B. Seely should have been chosen to fill the post vacated by the member for Colchester means, of course, that he will give up his military career, in which he has won distinction – alike in the Boer Campaign and in this war. He is a close friend of Mr Churchill, the Minister of Munitions, which is sufficient explanation of the selection. He was Secretary for War at the time of the Curragh affair in 1914.' Few remembered his single-handed battles in defence of War Office policy as Colonel Seely, MP, when a handful of members were agitating in pre-war days for an adequate Air Force.

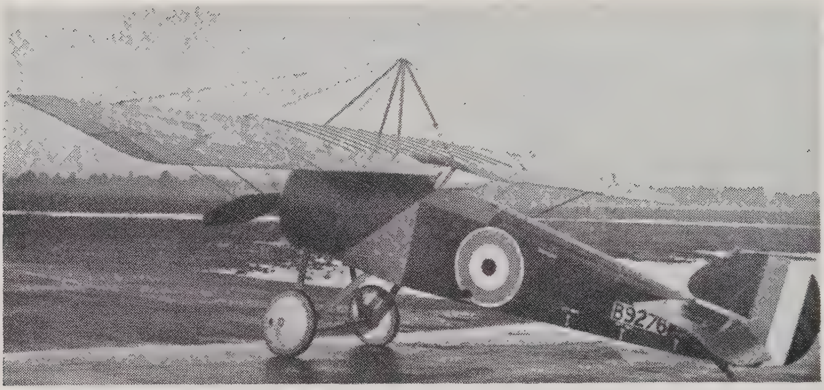
In July a great new German attack opened on a 50-mile front east and west of Rheims. Though the French had lost much ground in previous months there were rumours that Foch had fresh divisions in reserve and was only awaiting the critical moment. Many clung to hope in the growing number of United States troops beginning to pour in with the confidence of an untested heroism long forgotten by the British and the French.

Ceaseless overtime in the aircraft and munition factories was beginning to result in lassitude and even despondency. The pace slowed down. But it was far worse with many of the overworked pilots in France. Not bullets, but the strain was killing them. Wrote a fighter pilot: 'We all drank too much. Many were the dawn patrols by hung-over pilots; but I am sure the Hun was in the same deplorable state because whichever side saw the other first, turned off and avoided being regimental about the war. Live and let live was best, for none were in fit state to die so early in the morning. We all developed nerves, but these were dormant until some goof in the Mess mentioned flying and fighting: then reaction would show. One would light a fag and vaguely blow the lighted end; another might fold arms round knees and absently wring his downheld hands; others would leave the Mess without a word. My jaws would clamp, and I couldn't speak. On my last day there I couldn't lift my feet and dragged across the field to my plane and had to get the mechanics to steer my foot into a step and boost me into the cockpit. Just a nod for "contact" was the best I could manage. Yet as soon as the engine took hold I had the sensation of a slip knot becoming untied, and a grey net flowed down from the top of my head and off the toes of my boots and I felt FINE.'

There was no let-up. Fresh men and new machines flowed in to replace the worn and scrapped. Among them were a few trench-fighting T.F.2 Salamanders, which was substantially an armoured version of the Camel fitted with Snipe wings, and powered with the B.R.2. Because of its 650 lb of armour-plate constituting the front portion of the fuselage it weighed 1,844 lb empty – which was about the same as a production Snipe loaded with guns and full military stores, fuel and oil, though without pilot. Low straffing of the trenches was becoming an essential feature of war on the Western Front. Many losses with Camels, S.E.s, and D.H.s had been incurred from rifle fire entering the vulnerable fuselage undersides. So the Salamander was made with a box-like steel structure extending from engine bulkhead to lower wing trailing edge, which contained fuel tanks and pilot, and similar armour formed the rounded fairing behind him. Cleared by the Sopwith experimental department late in April, the prototype had been sent immediately to France for Service trials, and ordered for extensive production. Later it was intended to fit downward-firing guns like the special trench-straffing Camels, supplementing the two fixed forward-firing Vickers mounted in standard Sopwith fashion. As soon as this modification was completed, Herbert Smith was instructed to produce an armoured two-seater, powered with a 230 hp B.R.2, and of similar size and appearance to the two-bay 2F.R.2 Bulldog rather than the 200 hp Clerget-

The close relationship of Sopwith Snipe and armoured Salamander can be seen from these identical three-quarter views. However the Snipe weighed 2,020 lb and the Salamander 2,512 lb, though with little detriment to speed.

Production in full swing with the final version of the Sopwith Dolphin at Kingston-upon-Thames. Twin Lewis guns can be seen on the forward spar tube of the centre-section, which with the two fixed Vickers made this the first four-gun fighter. (*Fleet Air Arm Museum.*)



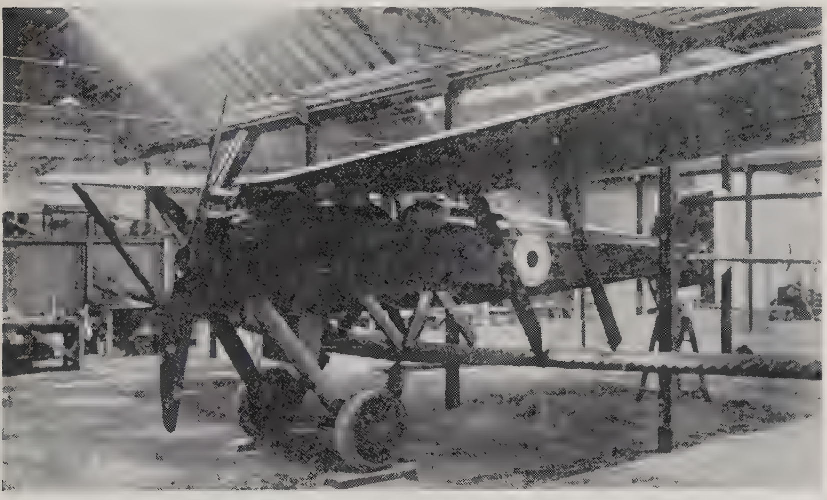
The Sopwith Swallow, taken at Martlesham, used a basic Camel fuselage like others of that company's single-seaters, but was too late for Service use. (*A. R. Boeree.*)

powered back-staggered Hippo which had proved disappointing, at least in part due to interference between the pilot's open cockpit and the centre-section immediately behind it. This was the Buffalo.

Harry Hawker at about this time devised a new 'runabout' to succeed his miniature Bee, and with typical ingenuity made a monoplane from a Camel fuselage and a modified two-bay top wing from one of the experimental biplanes which he fitted high-wing fashion, wire-braced to the lower longerons and to a pylon above. The result was so effective that there seemed hope of introducing a strengthened and more powerful version; but Herbert Smith had five other designs of widely differing

The Sopwith Snapper was the same size as the Camel but flew more like an S.E.5. At Martlesham, maximum speed was recorded as 140 mph at 3,000 ft. Service ceiling was greater than any other fighter's except the Martinsyde F.3 and F.4 – but the 360 hp A.B.C. Dragonfly again spelt failure. (*Imperial War Museum.*)

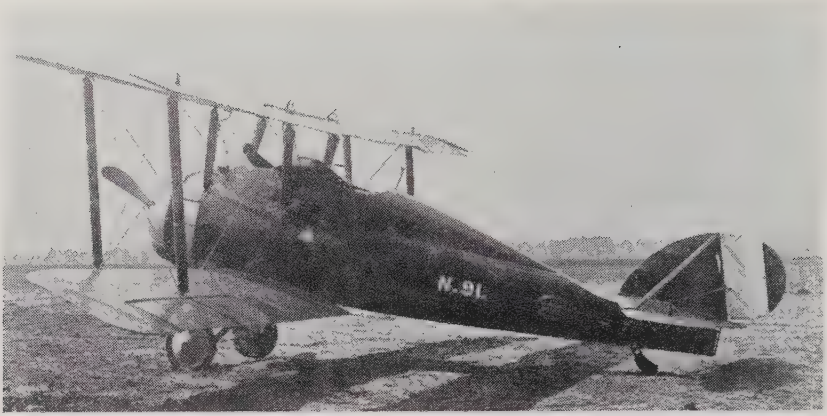
specification, and gave it low priority, particularly as an experimental installation of a Dragonfly in a Snipe had recently been so successful that production drawings were being made for a derivation named the Sopwith Dragon. Of the relationship between pilot and designer, W. O. Bentley commented: 'I had the highest admiration for Harry Hawker. He knew exactly what the fighting pilots wanted, and saw they got it. He was a delightful person, but found it difficult to get along with Smith. In fact they often were at loggerheads, and seemed to have little time for each other.' Perhaps it irritated Smith that the great Sopwith test pilot could criticize, and condemn if need be, the projects which were his final responsibility as chief designer, and Hawker could be intolerant if thwarted.



Unknown until J. M. Bruce found a photograph of it, the long-winged Parnall Zeppelin fighter appeared rational for its purpose, and many years later seemed reincarnated in the Vickers Vespa by the same designer. (*Courtesy J. M. Bruce.*)

Another important machine for which the B.R.2 was earmarked was the compact, remarkable 28 ft span two-seat biplane built by Parnall & Sons at the inspiration of the nervously mercurial Harold Bolas who had joined the company from the Admiralty during the Farnborough exodus. It bore traces of Harris Booth's influence, and particularly of the A.D. flying-boat and the A.D. Navyplane on which Bolas had been earlier engaged. Camden Pratt, Parnall's initial aircraft manager, had left when the novel long-winged anti-Zeppelin single-seat fighter he had designed proved badly over-weight. One of Bolas's first tasks had been to burn it in order to make space for his own experimental construction.

The little factory at Mivart Street, Eastville, Bristol, which in pre-war days had been devoted wholly to cabinet work, was filled to capacity with landplane rebuilds of the Hamble Baby seaplane called the Hamble Baby Convert, characterized by a skid undercarriage of exceptionally wide track. In one bay of the building, five prototype Parnall N.2A, recently christened



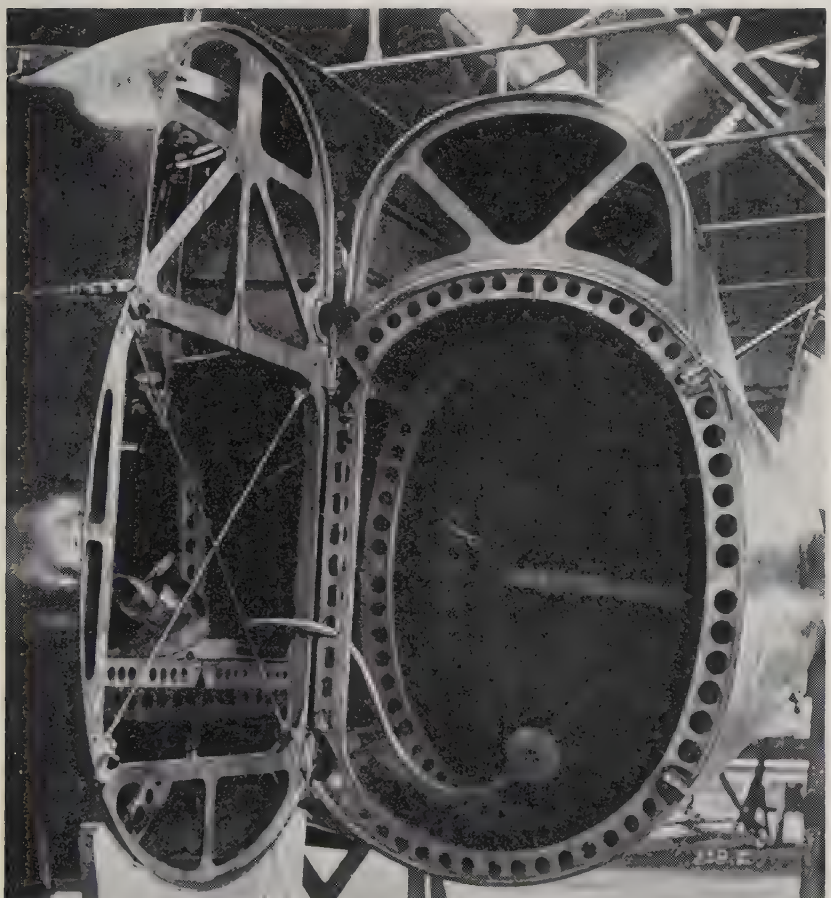
The wing gap of the Parnall Panther was abnormally great, principally to provide satisfactory upward view for the pilot. Bolas firmly believed in small rudders to keep the pilot out of trouble, but they were inadequate for spin recovery. (*A. R. Boeree.*)

Panther, were in varying stages of completion. The first had been flown, but longitudinal control proved too heavy, so the elevators were being fitted with large horn balances, and the forward rake of the tailplane rear spar was increased to obtain the requisite aerodynamic centre. For the novel arrangement of tailplane spars in triangular formation Bolas was granted Patent 129,687.

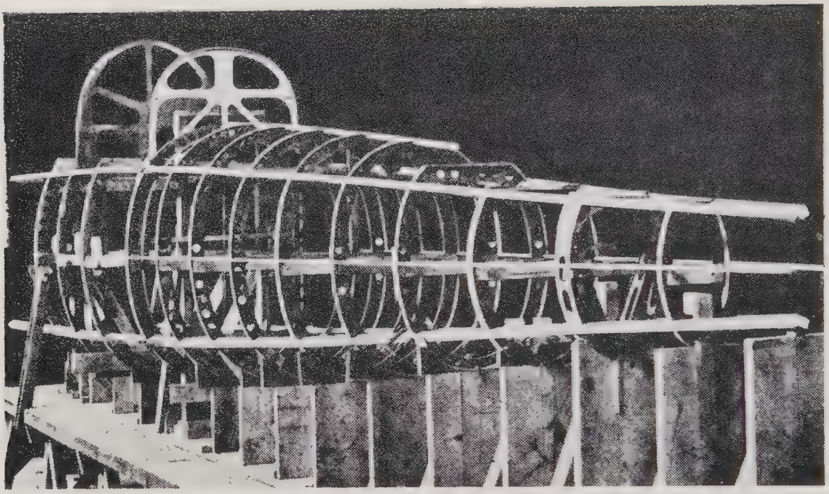
The entire machine contained many unconventional features, of which the most obvious was the circular section monocoque fuselage of diameter dictated by the B.R.2 engine, on which was superimposed a similarly constructed segment containing cockpits for pilot and observer, with a high-seated position for maximum view, but entailing difficult entry for the pilot who had to scramble up the fuselage and drop down through an aperture in the centre-section. If this stubby-winged biplane turned over he, like the Dolphin pilots, could not escape – but the construction enabled the basic fuselage to be made watertight, thus eliminating flotation bags, though its most unique feature was division into two portions abaft the rear cockpit with hinge to starboard and two-pin lock to port so that the rear fuselage could be folded laterally against the mainplanes to reduce shipboard stowage space. A fixed dihedral hydrovane forward of the wheels was fitted to subsequent aircraft to counter nosing over when ditching, though it could trip the machine in a bad landing on grass. Other special features were ailerons inset from the tips, and a special engine ring-mounted on four triangulated tubular structures removable as a unit, including ancillaries. The dome-shaped, circular forepart of the cowl blended into the ellipsoidal section fuselage to give wide angle to the pilot's downward view, and provided cooling air for the exhaust ejected in a gap between cowl and fuselage. Many other novelties were also the subject of patents, but the raked rudder-post was a Bolas foible which, coupled with the extraordinarily small rudder, did not seem based on wind-tunnel work,

and at low speeds was even more inefficient than usual. Nevertheless the Panther was generally accepted as a pleasant if slightly sluggish aeroplane to fly.

Disappointing though its ground level speed of 112 mph was, the compactness of the Panther made it the only machine likely to fulfil the N.2(a) specification for a two-seat reconnaissance aircraft capable of operating from carriers, and to save delay, contracts were placed for 312 aircraft shortly after the company had been taken over by W. & T. Avery Ltd. Meanwhile the third prototype was tested with its front hydrovane and inflatable air-bags under the wing-tips, still relying on the fuselage for central buoyancy. To reassure those who doubted the strength of the $\frac{1}{16}$-in birch plywood monocoque fuselage, since it was the first time this form of



A novel feature of the Parnall Panther was the folding of the fuselage aft of the rear cockpit instead of folding the wings. For preliminary ditching trials an inflatable air-bag was inserted in the rear fuselage. (*H. Busteed.*)



Harold Bolas on leaving the Admiralty could still be counted on for novel solutions, exemplified by the light ply-covered fuselage of the Parnall Panther with super-imposed cockpits for crew. (*H. Busteed.*)

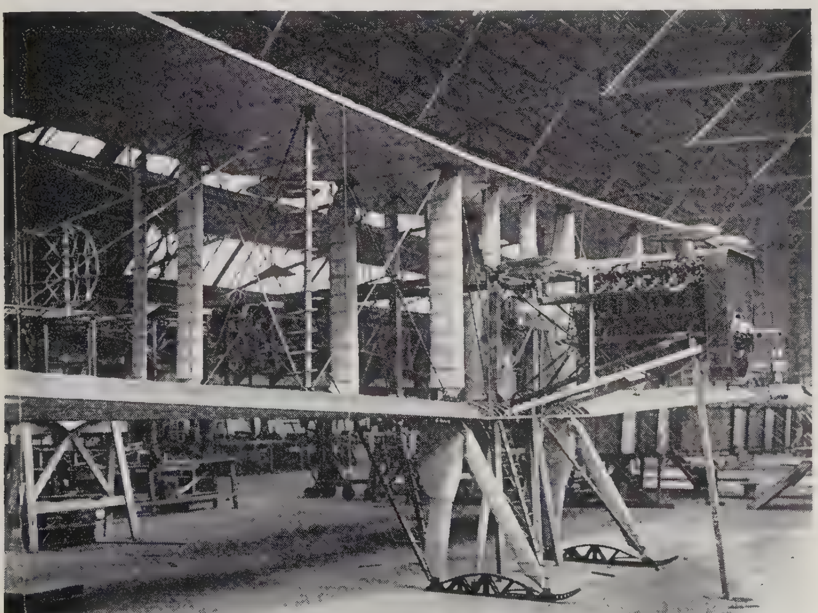
structure had been selected for extensive production, a fourth prototype was sent to Farnborough for full-scale load tests.

Currently Bolas's friend and mentor, that remarkable and outspoken character, Harris Booth, was superintending design of the Blackburn N.1B single-seat flying-boat, as a rival to the Supermarine Baby which had been flown in February by Flt Lieut Goodwin and found promising despite the minute rudder. Designed in the Bolas tradition by F. J. Hargreaves, the Supermarine's kinship to the A.D. boat was very apparent. Harris Booth had benefited to the extent of giving the little Blackburn boat twin rudders mounted between upper and lower surfaces of a patented biplane tail in which the upper had inverted camber and negative incidence to counteract change of trim between engine on and off, and the two fins were given opposing angles 'to reduce yawing due to the spin of the slipstream'. A string of patents testified to many unique features of the Blackburn N.1B, including such ideas as using the wing-tip floats as receptacles for mail, merchandise, or petrol; others dealt with Booth's next design, a large torpedo-carrier intended as an improvement on the Sopwith Cuckoo. The latter's Mark IX torpedo had proved ineffective against heavily armoured vessels, so the new machine was required to lift a Mark VIII torpedo which contained nearly twice as much TNT. Both Blackburn and Shorts submitted designs, and each received a contract for three prototypes.

Harris Booth's proposal, the Blackburd, was a three-bay biplane of 52 ft span with folding wings employing steel-tube interplane struts flexibly faired with ribs and fabric. The fuselage was uncompromisingly ugly, with top and bottom parallel from nose to stern-post. For ease of production, it had individual side and top structured panels with their own strip

longerons so that adjacent side members of the two sections could be connected during assembly to form a single longeron. The fin and its typically small rounded rudder was adjustable as a unit to vary its incidence for directional trimming. The undercarriage was a formidable swinging structure comprising a girder steel skid each side suspended from twin sets of transverse V-struts supporting a jettisonable cross-axle and wheels sprung by telescopic rubber-buffer shock-absorbers attached each side below the front inner struts. Tested by Capt R. W. Kenworthy in the spring, skid landings without wheels were found feasible, and the machine went to Martlesham in June for handling and performance tests, lifting nearly 1,700 lb payload, but the 350 hp Rolls-Royce Eagle VII could only drag it at a maximum speed of 100 mph. As a flying machine it was bad: the rudder was dangerously ineffective; at all speeds there was extreme nose-heaviness; and with flaps down it was uncontrollable laterally. The idea was widespread that a new aeroplane was either right, or wrong and unalterable, though the second prototype was given a larger rudder.

Almost as ungainly in appearance, though less archaic, was the dimensionally similar but more functional Shirl designed by Oswald Short and draughted by Francis Webber's team. As a temporary arrangement for the first flight in the hands of Lankester Parker on 27 May, a normal cable-braced jettisonable V-undercarriage and cross-axle was used to permit dropping the torpedo which was slung directly above them, but both the



The Blackburn Blackburd prototype, under construction at Olympia Works in May 1918, reveals the nearest interplane strut and the skid with Harris Booth's method of fabrication which was estimated to save 120 lb on the empty weight of 3,228 lb.

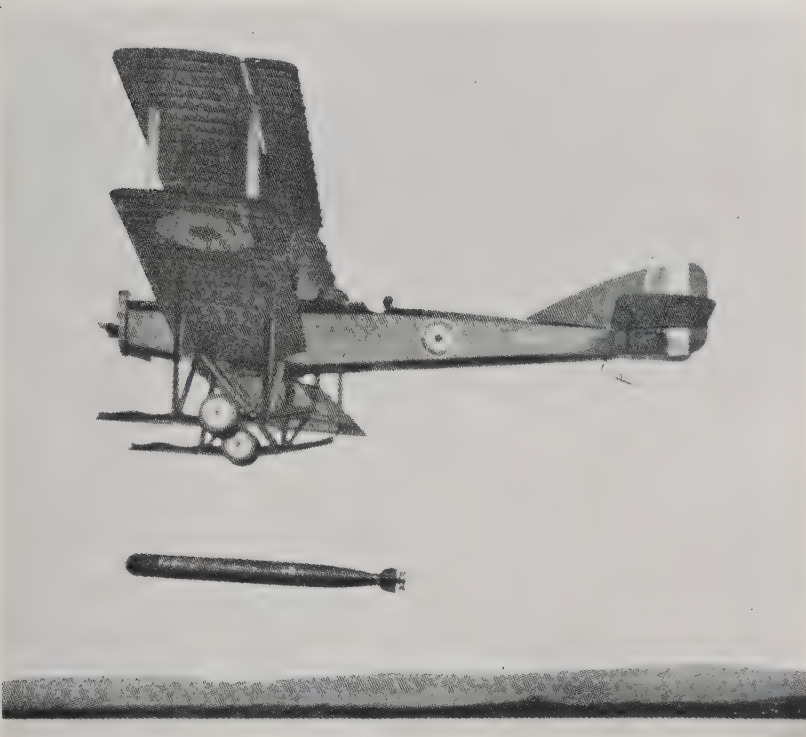
next two prototypes had individual forms of a divided-structure undercarriage with two wheels on a skid each side. Tested at Martlesham in June, the Shirl, as would be expected, revealed much the same performance as the Blackburd, and neither seemed good enough to embark on production, though an order for the Shirl was under consideration. For the time being the RAF must make do with the Sopwith Cuckoo – for which Blackburn had already received orders for 50, powered by the Sunbeam Arab, urgently needed by Admiral Sir David Beatty for a heavy air offensive against harboured German ships. The decision was particularly disappointing to Oswald Short, for Lankester Parker described the Shirl as: 'One of the finest machines ever to pass through my hands. With it I made my first long flight in 1918 from Grain to near Edinburgh in 4 hours 37 minutes. I had enough fuel left to make the return journey. It had an extraordinary take-off and a rapid climb, and its directional stability was such that I could, and did, fly through cloud for quite long periods with the aid only of a compass and a cross-level. It had some remarkable qualities.'

The prototype Short Shirl underwent official trials at Martlesham in June 1918. Although a 1,425 lb torpedo was carried it could only be dropped if the undercarriage was released and the machine ditched, for which purpose the ply fuselage was watertight. (*Imperial War Museum.*)

Oswald was certain that he had enemies among senior Air Board technicians who influenced purchases. 'Two of these officers I had previously known at Eastchurch as they were interested in aircraft construction,' he said. 'They evidently considered Short Brothers' success due to early favouritism from the dashing Commander Samson. Such was not the case as he was a keen critic; nevertheless they saw opportunity to turn the tables. Horace they would have admitted as an outstanding designer, the genius he really was, but they had no good opinion of me.' As Controller of Technical Design, Colonel Alec Ogilvie, and his assistant Lieut-Col Bristow, had justifiable preference for Fairey's seaplanes, and probably still regarded Oswald as inexperienced compared with his late brother.

The difficulty of designing a satisfactory aeroplane, let alone a perfect

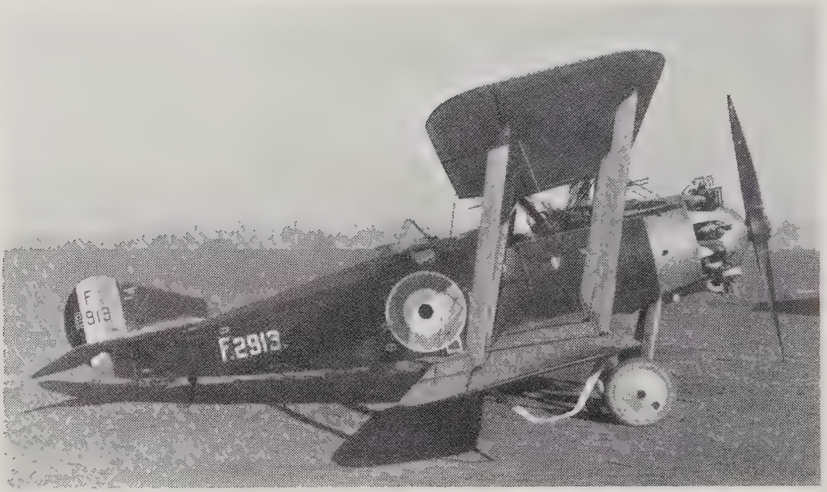
one, was evident everywhere. Sometimes a new machine would be nearly right; at others impossible. Weir's policy of loading the board with chances was the only possible course when cause and effect were so little understood. Among several competitors for any particular class, at least one might emerge which had good performance and handled well after relatively minor modifications. Each major aircraft factory was basically



The second Short Shirl had a divided skid undercarriage with no cross-axle. Torpedo dropping was tested at East Fortune, but the machine was found tail-heavy with torpedo and nose-heavy without it. Contracts for 120 Shirls were eventually cancelled in favour of more Cuckoos. (*Crown Copyright.*)

a great production unit; but one special corner, hangar, or small experimental shop was the empire of a designer and his staff working as a unit independently of the main business of constructing aeroplanes in greatest possible number.

Many were the crashes of new experimental aircraft, often due to dangerous handling characteristics; occasionally misjudgment by the pilot; but all too frequently because of engine failure. Of the latter, the A.B.C. Dragonfly was giving its full quota. The new Westland two-seat fighter, that smart-looking Weasel, had just piled up in a potato field for this reason, and was burnt out. The second Wagtail smashed its undercarriage.



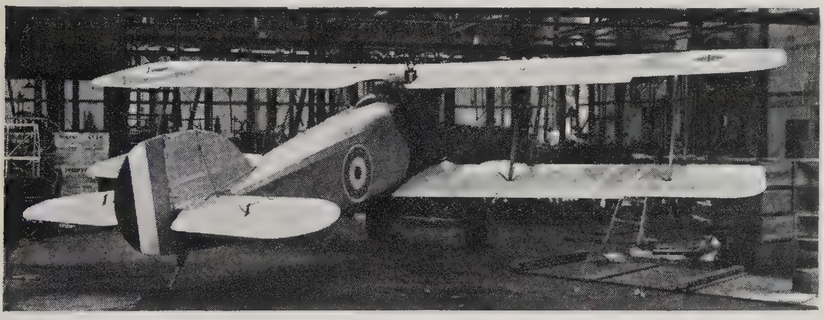
The Westland Weasel two-seat fighter had a pleasing shape, and handled well. It was faster than the equivalent Sopwith Bulldog Mk II and just exceeded the speed of the Austin Greyhound – but the refractory Dragonfly engine ruined its chances. Nevertheless a useful series of flight trials was made with 'helmeted' cowling.

Sometimes disaster struck more brutally. Vickers once again experienced tragedy on 29 July – for Capt Charles Gordon Bell, their chief pilot, was killed while flying the F.B.16E in France at Villacoublay. Capt Boeree, who was there demonstrating the prototype Martinsyde F.4, saw it happen. 'Gordon Bell was suffering from the effect of a skull injury and couldn't stand heights,' said Boeree, 'so I agreed to do his climb and speeds at altitude.' But first, Gordon Bell made a low level exhibition flight 'to warm up the engine'. As he came in to land, the tailplane folded up, and he dived in, just as had Capt Simpson on the first flight of the original proto-

Success attended the private venture Martinsyde F.3 and led to a contract for a revised machine, the F.4 (illustrated), powered by the 300 hp Hispano-Suiza. So successful were trials in June 1918 that big production orders were placed on the assumption that it would become the standard fighter for 1919. (*Courtesy The Royal Aeronautical Society*.)

type. Vickers, it seemed, were not fated to become successful fighter designers.

'Everyone who knew Gordon Bell well lived in a continual state of exasperated affection towards him,' wrote C. G. Grey. 'At times people who did not know him thought he was mad – but it was his exuberant sense of humour which really upset the stolid Englishman. Somehow Bell's quaint sayings were made funnier still by his queer little stutter, which always seemed to add point to his remarks.' His Dalmatian and beautiful white Hispano car were all part of the accoutrements of this vivid, irritating, lovable personality.



The two-bay Vickers F.B.16E was a high-altitude version of the stubby F.B.16D, with ceiling increased from 18,500 to 24,000 ft. The French firm of S. A. Darracq proposed building the type with either Lorraine-Dietrich or Hispano-Suiza engines. (*Vickers Ltd.*)

In mid-August the great scientist-professor Colonel Bertram Hopkinson fatally crashed while piloting a B.E.2e in bad weather. Yet another programme of great importance had just been initiated by him in which Henry Tizard, Harry Ricardo, and David R. Pye were delegated to investigate causes of detonation in the low-grade straight petrol currently used, and which had just achieved status of availability in 50 gal drums instead of the customary green or red painted 2 gal tins. As successor to Hopkinson there could be no other choice than his Assistant Controller of Research and Experiment, Tizard, now a Lieut-Colonel.

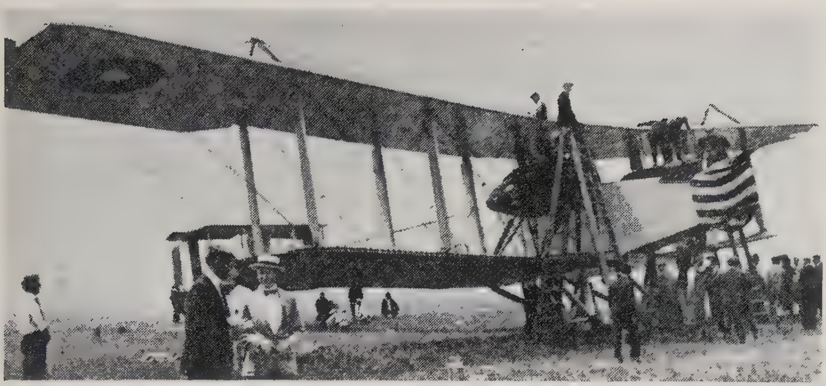
Meanwhile it was learned from German newspapers obtained in Holland that, on the last night attack on England, Captain Strasser, the leading Zeppelin commander, had been killed. Loss of this national hero added to the increasing dismay in Germany; not only was subsistance level now marginal, but their troops on the Western Front were suffering vast losses and falling back. On 18 July – two days after the ex-Czar and his family had been murdered – Marshal Foch at last struck, copying the German method of attack without giving warning by preliminary artillery fire. Bends in the line at Château-Thierry were being flattened by the French, and the English were righting the position on the Amiens Front. August newspapers reported a string of successes. Soissons and the Crise Line were won on the 3rd; the British took Morlancourt on the 9th; Montdidier was carried on the 10th; the French completed capture of the Lassigny massif

on the 15th; British troops crossed the Ancre on the 16th, and General Byng opened a strong offensive north of the river on the 21st, capturing Beaucourt Bucquoy, Ablainzeville, Meyermeville, and Courcelles. On the 22nd the British had recaptured Albert, taking 5,000 prisoners, occupied Lassigny, and continued to press forward. On the 27th the French captured Roye and the British captured Bapaume. On the 29th the French took Noyon, and Bailleul was occupied by the British on the 30th. At the beginning of September the Germans were retreating from the Vesle. So it went on.

Yet there was little confidence among the masses at home. These fluctuations of war had been seen before. The great grey army seemed certain to fight its way back. Hope must be pinned on the undoubted fact that the American armies would be available next spring in full force so that a last great attack could be made. Nevertheless it became increasingly evident that the British troops would successfully hold the line, and hope grew that the end was not too far off. For a few days people went less despondently about their daily affairs – though those in the factories seemed to become even more contentious. Yet the Ministry of Munitions under Churchill was doing everything possible to ensure harmonious working by adopting conciliatory proposals such as management's recognition of shop stewards, and establishing in each company small committees of these stewards to discuss working conditions directly with their management. The mere fact that the Army had reached the Hindenburg Line seemed to inspire more and more demands. On 1 September the Lancashire cotton operatives came out, soon followed by the railwaymen and then the shipwrights on the Clyde. Conciliation became another word for granting easy money. The slippery path had started.

5

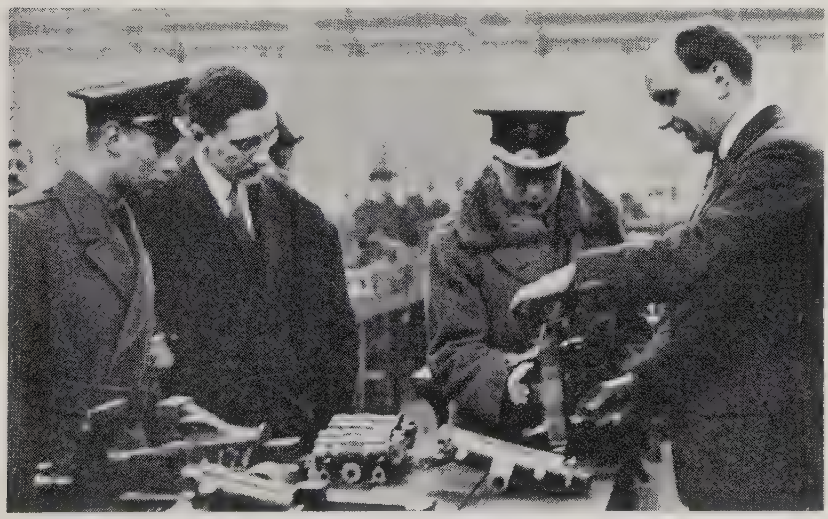
Aircraft production reports from the USA were proving more hopeful. There had been great jubilation when the first American-built Handley Page O/400 was launched at the beginning of July. Colonel the Master of Sempill, accompanied by Capt E. B. Waller, had piloted its initial flight, reporting somewhat obscurely that: 'The machine handled as satisfactorily as the British model.' Notabilities from the American Aircraft Board had been present on what made a great occasion, and Benedict Crowel, US Assistant Secretary for War, took the opportunity of reading a homily on the necessity of Americans not to be over-confident of their achievements. In more hopeful vein, W. A. Chamberlain, of Handley Page, expressed the opinion that the Liberty-powered O/400 was capable of transatlantic flight to England via the Azores. Indeed, the *Daily Mail* was already looking forward to peace-time conditions, and renewed its pre-war offer of a £10,000 prize for the first aeroplane to fly the Atlantic. H.P. impressed on Volkert and Chamberlain his preference that the V/1500, rather than the O/400, should make the journey, for it might lead to yet more profitable orders from the Americans. When he visited the USA he mentioned the



The *Langley*, first of the American-built O/400s, was flown at the Government Aviation field at Mineola, Long Island, on 6 July, 1918, piloted by Colonel the Master of Sempill, with Capt E. L. Austin as assistant pilot, and General L. Kenly, chief of the Department of Military Aeronautics in Washington, in the nose cockpit. The machine had been built by the Standard Aircraft Corporation.

possibility to Alexander Duckham, who in peace-time was chairman of the oil company bearing his name but was now a member of the British Air Board stationed in the USA as Controller of American aircraft assembly.

Mrs Harry Bowers Mingle, wife of the president of the Standard Aircraft Corporation, builders of the American O/400, officially named the prototype *Langley* in honour of the man whom they regarded as prior in achievement to the Wright brothers; though this may have been partly because Orville Wright, the survivor of the two, was not greatly liked.



In England, at Cricklewood, Frederick Handley Page (right) and his Works Manager show the Prince of Wales (centre right) and his brother Prince Albert (left) the intricacies of aircraft manufacture.

Recently knighted Sir Henry Fowler, Britain's Deputy Director of Aircraft Production, spoke of the machine as 'an augury of the work that is going to be done in the United States to build up our ascendancy in the air'.

In London, Lord Weir, presiding at the Wilbur Wright Lecture delivered by Dr Durand, Scientific Attaché to the American Embassy, said: 'Tests recently applied in France and this country to the latest American engine, the Liberty, have justified the prediction that it will prove a most valuable contribution to Allied resources. The experiments have placed the engine in the very first line of aero-motors. It is well understood that some criticism will be directed against the slowness of production of these motors during the last three or four months, but I would like to point out that a considerable interval will, and always must, elapse between the experimental and commercial production of any new motor.' Weir had learned the bitter lesson. He added: 'In the assistance given in aerial warfare the USA has already rendered very great aid in the way of personnel. The work of American pilots has won golden opinions from all with whom they have been in contact. It is the universal opinion that they are unsurpassed in their energy and modesty and for their willingness to learn and their desire to co-operate in everything. So far as personnel is concerned, we entertain the fullest confidence in the future success of the American Air Force.'

In the *New York Herald* appeared the ominous comment: 'General Pershing has cabled the War Department protesting against shipment to Europe of D.H.4 planes which have not been thoroughly tested in this country. The action of General Pershing adds new impetus to the demand by army members of the Aircraft Committee to take over the three principal aircraft factories by the Government. The Committee has been considerably disturbed by the frequent reports of aircraft accidents in the American Army and is now awaiting a detailed report from the War Department on this subject. Several members blame the weight of the Liberty motor for many of the fatal accidents. They believe that the finding of the Senate Military Affairs Committee, reported last winter, that the Liberty motor is not suited to light combat planes, still stands.'

But there was more enlightened opinion. Maj-Gen Brancker, Controller-General of British Air Equipment, was in the States, and at a luncheon in his honour, read an appeal from Lord Weir to send the British 'every motor you can'. Far away in England the Westland Works had a growing production line of D.H.9As awaiting these vital engines.

Before leaving the USA, Brancker told the American Government in his characteristically clipped and forceful manner that he endorsed Handley Page's belief that the Atlantic flight could be accomplished this year, and saw no reason why numerous aeroplanes should not be delivered in 1919 by flying from Newfoundland to the Azores, thence to Portugal and Britain or France. He said the British Government was considering the project seriously, and stressed that: 'The enterprise could be carried through with motors of 750 hp, capable of 40 hours flight. The machine would have a speed of 85 mph, but might be favoured by winds of 10 to

15 mph. Three main problems are involved: engine reliability, navigation, and weather forecasting. I am satisfied the Rolls-Royce motor would be able to do it this year, and that the Liberty should be able to do it next year. Navigation would also be all right; but weather forecasting was the more important factor, as there was the possibility of the aviator running into bad weather at sea.'

The Aero Club of America, on learning of this official pronouncement wrote to Handley Page's representative:

> Dear Mr Workman – As stated to you before you went to England three months ago, a group of patriotic people, anxious to assist the Government in solving the problem of delivering thousands of aeroplanes overseas, has offered to order a large Handley Page aeroplane provided you can assume the responsibility of delivering it to England by air. We would like you to give full details regarding the following points:
>
> 1. Will you accept an order for a Handley Page machine and responsibility of delivering it to Great Britain or France under its own power?
> 2. What will be the cost for such a machine?
> 3. How much must we pay extra for you to assume the risk and responsibility of flying across the Atlantic?
> 4. We know the life of an aeroplane is approximately 600 hours, and for motors when run throttled is some 500 hours, so the aeroplane will have had little wear and can be used for at least 400 hours more flying after it has crossed the Atlantic. Can you guarantee that the flight can be made with the motors throttled four-fifths of the time?
> 5. As the next most important factor is having two good pilots, may we enquire whether you have them available, and is their experience such that they would be successful in the flight across the Atlantic?
> 6. Would you and your associates be ready to take a large order for similar machines, and how soon could you produce after receiving the order?
>
> We appreciate that very large machines, like the Handley Page and Caproni, do not grow quickly old in design. They can always be used for bomb dropping at night and can conduct a continuous campaign of destruction against the bridges on the Rhine which are crossed daily by hundreds of trains loaded with German troops and munitions. If it were possible to wreck bridges and keep them wrecked, Germany would be unable to supply her forces in France and Belgium. Therefore there should be no delay in building large machines – the larger the better. We have had too much delay in this respect, and the cause of the Allies is suffering therefrom.

In his confident reply, Workman surprised the Aero Club by requiring a bonus of only 2,500 dollars above the cost of the machine to cover the expense and insurance of a transatlantic flight; but no such deliveries were made.

The idea of bombing essential German supplies was the crux of what Trenchard was attempting with his new Independent Air Force. Though D.H.9s had been operating on bombing sorties in France since May they were proving the sad disappointment predicted, for not only was their

carrying capacity small but the unreliability of the Puma engine was proving disastrous despite devoted attention by RAF mechanics in tuning them and fitting numerous maker's modifications. D.H.9s were being shot down by the score. Maj-Gen Salmond reported: 'Low ceiling and inferior performance oblige it to accept battle when and where the enemy choose, with the result that raids tend to become restricted to areas where protection can be afforded by the daily offensive patrols of scout squadrons.' Already in June, Trenchard had written from his Headquarters at Autigny-la-Tour stressing how vital it was to replace the D.H.9 with the more powerful D.H.9A. It represented remarkable organization that the first squadron was able to reach France on 31 August, for the earliest production contracts had only been placed in March.

The *Gazette* of 23 August announced the appointment of Maj-Gen Sir Godfrey Paine, KCB, MVO, to the post of Inspector-General of the Royal Air Force, and additional Member of the Air Council; Maj-Gen W. S. Brancker to be Master General of Personnel, in place of Maj-Gen Sir Godfrey Paine; Maj-Gen E. L. Ellington, CMG, to be Controller-General of Equipment.

'General Brancker, who has recently returned from America, should make an excellent Master General of Personnel,' pronounced one of the newspapers. 'He is a gunner and therefore has had a highly technical training, and has always shown himself to be an excellent controller of

With long-range aircraft came the need for improved refuelling methods compared with handing up two-gallon tins. Here an O/400 is being refuelled at Dunkirk from 100 gallon drums with the new hand-operated Bowser pump. (*Imperial War Museum.*)

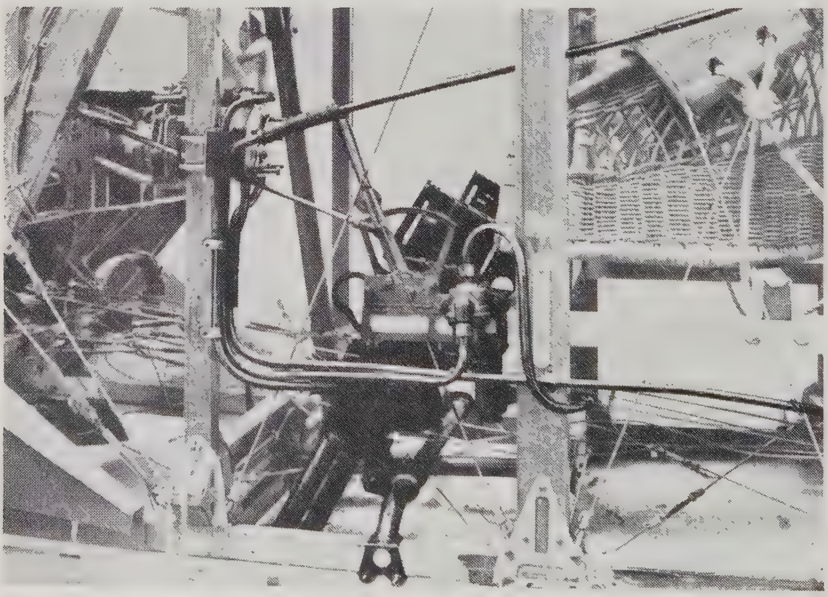
The barrels of two downward-firing guns of the experimental trench-straffing Sopwith T.F.1 Camel poked through an armoured floor, and were supplemented by a third Lewis above the centre-section but with no fixed Vickers. It led to the Salamander. (*Fleet Air Arm Museum.*)

men. General Ellington was one of the first General Staff officers to become associated with the RFC and served on General Henderson's staff for a considerable time before the war. Though not actually a technical man his thorough soundness as Staff Officer and proved ability as an organizer should guarantee his being a success in his Office – which, incidentally, he has occupied for some time as *locum tenens* during General Brancker's absence.'

Perhaps the recent contention with Trenchard and Rothermere caused Lloyd George in the Commons to omit all reference to the Royal Air Force when he reviewed the four years of war. 'The significance of the omission lies in the implication that if he did not think enough about the Air Force when preparing his speech, he does not think about it at other times sufficiently to realise its strategic and tactical importance when its claims come before him in his Office as head of the War Cabinet,' fumed C. G. Grey. 'Fortunately we have in Lord Weir one of His Majesty's principal Secretaries of State who cannot be ignored, both because of his strong personality and because of the importance of his position, when he brings forward a matter of urgency.'

Nevertheless the RAF was inflicting tremendous havoc and accepting heavy losses. A typical communiqué that August reported: 'Some of the

heaviest air fighting of the war took place between Albert, Amiens, and Roye road, where the enemy's air forces were considerably augmented. Shortly after the opening of battle 48 enemy machines were destroyed and 17 others driven out of control. Fifty British machines failed to return. During the six following days 185 enemy machines were destroyed and 89 driven out of control, and 123 British machines are reported missing. In addition British bombing squadrons throughout the week have attacked enemy aerodromes, railways and other communications, dropping more than 320 tons of bombs and causing great damage to military material and personnel. Much valuable help was given to advanced sections of British Infantry and to the Cavalry and Tanks by low-flying British scouts, which ceaselessly patrolled the battlefield, raking the already congested roads of the retreat with machine-gun fire. A notable feature of this phase of operations was practically continuous bombing of the enemy's bridges on the Somme by day and night. The RAF Independent Force has also made raids into German territory, attacking the stations at Karlsruhe, munition works at Rombach, the railway triangle at Metz, stations at Offenburg and Thionville, and an enemy aerodrome at Hagenau as well as a most successful raid upon the aeroplane and chemical works at Frankfurt. An RAF contingent working with the Navy, successfully attacked a Zeppelin over the North Sea and brought it down from a great height in flames.'



View of the trench-straffing Sopwith Camel cockpit, showing the twin guns steeply mounted beneath the pilot's legs, approximately on the C.G., thus enabling gun-fire through the bottom of the fuselage and easy clearance of stoppages. (*Fleet Air Arm Museum.*)

Things were beginning to move fast. Limited though the Americans were in numbers, their great attack on St Mihiel salient in mid-September had proved devastatingly successful, and the German line which jutted into the French defences since earliest days was utterly crumpled. Concurrently the Bulgarian front line was pierced near Monastir, and Bulgaria begged for an Armistice. On that same day the British and Belgians attacked in the extreme north, and Messines Ridge was recaptured, the French also gaining St Quentin. At that point all the German Secretaries of State resigned. It seemed that the Teutonic Empire's power of resistance had gone. Equally suddenly the entire Allied line gained an air of reinvigoration, instinctively feeling that a last great effort could end everything.

Low-flying British aircraft seemed everywhere, often in grave risk of collision as they sprayed trench after trench with their guns, and the stage was set for a long string of successes when Cambrai was taken two days later by British and Canadian troops. On 7 October, Ferdinand of Bulgaria abdicated. In the next week General Plumer's forces captured Werviecq, Comines and Halluin, taking 150 guns, and two days later took Douai. Simultaneously a great Anglo-Italian advance began.

It began to seem that the vast American reinforcements would not be required, and that Germany might be defeated before the target date of next year. Yet if some were hopeful, most were incredulous that this could be the beginning of the end. They looked around. The war had seemed a lifetime. Contented England of pre-war days seemed submerged in drabness; life was bounded by restrictions; they were half-starved; they were tired of reading incessantly of strikes and clashes of trade unionism. Even the new Women's Royal Air Force seemed plagued with dissatisfaction. The *Daily Express* queried: 'What is the matter with the Women's Royal Air Force? Miss Douglas-Pennant, Head of the Force, resigned recently and with her several officers at Head Quarters. It is understood that she has laid her case before the Prime Minister. Mrs Gwynne-Vaughan, her successor, has had wide experience in dealing with women of the Auxiliary Corps in France, but there is still considerable unrest in the Force, and great difficulty in getting suitable officers.' It was said that women candidates for commission selected by Labour Exchange officials had been turned down as unsatisfactory, whereas others of better education and social status were accepted. Here was a storm in a teacup which was to take long to subside – but to add to everybody's troubles, towards the end of September a great influenza epidemic began to sweep the country. People fell ill by the thousand and then by the hundred thousand. Public services and factories began to be disrupted, and the work of government departments was almost paralysed.

6

Although in the Snipe the next generation of rotary engine fighters of small inertia and swift manoeuvrability had been established as suitable for pilots of Camel category, there was still necessity of producing a successor

of improved performance for pilots used to fighters with heavier water-cooled engines as exemplified by the S.E.5a and Dolphin. The new Bristol Scout F using the vibration-prone Arab was rejected, as had been the Hispano-powered Vickers F.B.16D, in favour of a re-arrangement of the handsome Martinsyde F.3 with 300 hp Hispano-Suiza replacing the 275 hp Rolls-Royce Falcon – and by slight readjustment of weights the pilot was moved some 18 inches farther back, giving an all round view superior to any contemporary fighter. With its new look the F.4 lower wing had 6 inches less chord than the top, giving greater rake to the forward inter-plane struts. Heavier than the latest S.E.5a by some 200 lb, the F.4 proved the fastest fighter in the world. Capt Boeree on testing the un-numbered prototype at Martlesham recorded the performance as:

Ground level speed	153½ mph
Speed at 20,000 ft	126 mph
Ceiling (Standard atmosphere)	27,600 ft
Rate of climb at full load	
10,000 ft	4½ minutes
20,000 ft	21 minutes

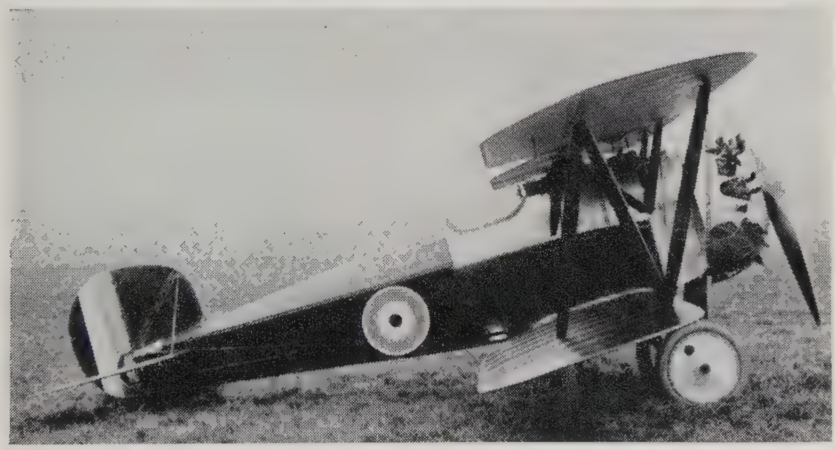
It is possible that a special propeller was fitted, for official reports M 210 A & B give slightly reduced performance, but in any case it beat the S.E.5a hands down in speed and climb. In the time that the splendid S.E. took to attain 15,000 ft the brilliant Martinsyde would be a mile higher. This was because its power loading was only 7¾ lb/hp compared with 10 lb/hp for the S.E.5a, and the wing loading had been reduced from 8·2 lb/sq ft to 7·2 lb/sq ft, at the expense of 6 ft increased span and greater inertia. Though the latest Snipe was a mile or two slower than the S.E.5a at 15,000 ft, it could save a minute or two on climb to that height, compared with Farnborough's fighter, but had the great merit of smaller longitudinal inertia due to the rotary engine and so was quicker to turn; yet its special advantage in the eyes of Lord Weir was that presently the fully developed A.B.C. Dragonfly would be fitted, and the technical pundits calculated it would then be even faster than the Martinsyde F.4. Meanwhile the Martinsyde was ordered in huge quantity by Britain, France, and America. George Handasyde had at last achieved real success, for next year's air battles would depend on his machine.

Until recently it seemed possible that Roy Fedden's newly developed Mercury engine, which had recently been flown by Raynham in the third Bristol Scout F, might prove a substitute for the A.B.C., but although a production order for 200 engines had been awarded it seemed that the two-row design had snags, for the Cosmos Engineering Company, who had taken over the Brazil Straker concern, were considering construction of a new single-row radial named Jupiter. This atmosphere of doubt gave added reason to back the Martlesham-approved impressive-looking Martinsyde F.4, particularly as the French could guarantee reasonable engine supplies.

Said Handasyde's Belgian protégé, Marcel Lobelle: 'Every piece of the

George Handasyde (left) linked up with H. P. Martin and went on to produce some of the most graceful designs of the period – the famous Martinsydes. Charles Richard Fairey in 1912–13 built Dunne's tail-less aircraft, then joined Short Bros. gaining invaluable experience of seaplanes which led to founding his own company in 1915.

F.3 and its development the F.4 was designed by 'Handy', as his former chief designer had joined W. G. Tarrant Ltd who, with W. H. Barling of Farnborough as chief engineer, were constructing a vast triplane. Brujac was Tarrant's chief draughtsman, and he offered me a job because he was French and I could speak the language. So I left Handy, although I felt indebted that he had given me a start – and he also gave a taciturn young man called Sydney Camm his start. Camm worked in the stores, built model aeroplanes in his spare time, and badly wanted to get into the drawing office. From the moment I started at Martinsydes he seemed suspicious and jealous of me because I had been given a job on design. Only after I left, and the number of draughtsmen had to be increased for the F.4, was he

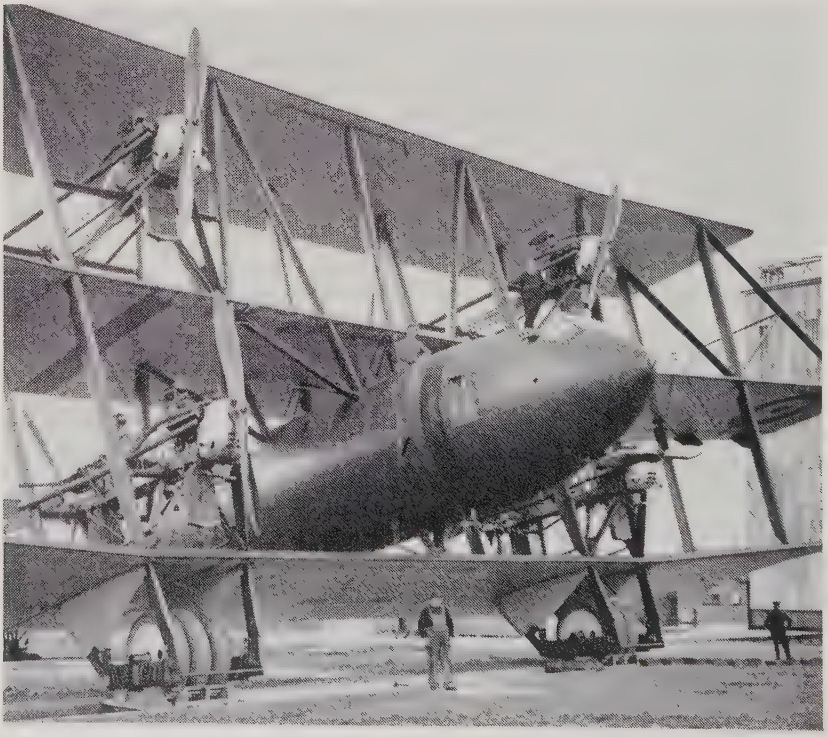


The Bristol Scout F was flown in April 1918 with the new Cosmos Mercury designed by Roy Fedden. Although performance was considerably improved, particularly climb, handling was adversely affected. (*Bristol Aeroplane Co.*)

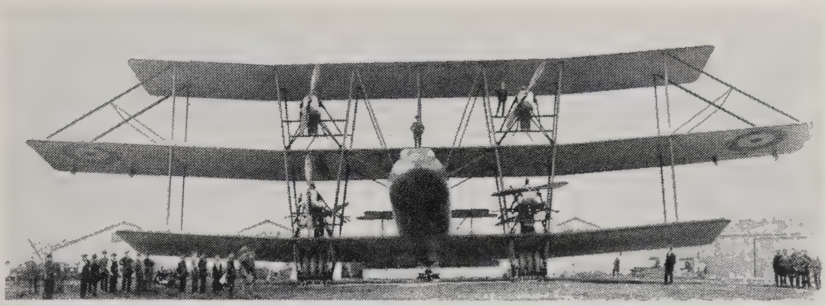
given the chance of amending production drawings. He was a queer chap, with a bit of a chip on his shoulder.'

The nearby Byfleet firm to which Marcel Lobelle had transferred his allegiance was renowned as a woodworking contractor, and had been given considerable sub-contract aircraft work since outbreak of war. Mr Tarrant was inventive, and, like McGruer who made the built-up tubular longerons and struts for Handley Page, was much exercised with ingenious use of small lengths of timber to make large units such as lattice wooden girders for big buildings. He patented a method of constructing aircraft spars with flanges built of three or more parts grooved at adjoining faces to receive the beaded ends of lattice cross-braces or webs, thus avoiding use of metal fixings. From this he devised a system of building circular girders for large fuselages, and secured Patent 130,623 in November 1917.

At Farnborough he met the ambitious W. H. Barling, who had been one of Major Green's designer-draughtsmen, working under Kenworthy on the R.E.8. Between them, Tarrant and Barling conceived a very clean biplane with cigar-shaped fuselage and overhung top wing of some 130 ft



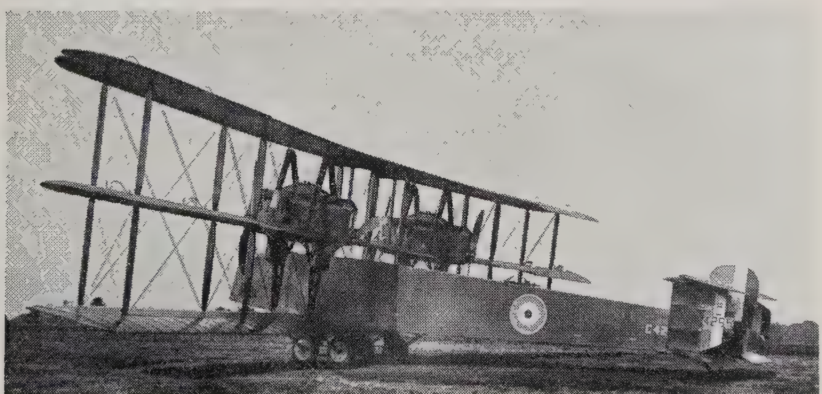
Viewed outside the big airship shed at Farnborough, the Tarrant Tabor seemed a mighty piece of engineering, but it was in any case too late for its intended bombing function and its economics with six engines too costly for civil use. (*Courtesy Royal Aircraft Establishment.*)



Front view of the Tarrant Tabor. Span of the centre wing was 131 ft 3 in and of upper and lower wings 98 ft 5 in.

span, which when fitted with four of the 600 hp Tiger engines under design at Siddeleys would beat the V/1500's performance. However, the Tigers could not be ready in time. Before long a third wing of the same size as the smaller lower wing was superimposed to form an alternative six-engined triplane using 450 hp Napier Lions, of which the added pair was fitted between top and middle wings, high above the main tandem units. In this guise the empty weight was as great as the fully laden weight of the V/1500, and the triplane's all-up weight revealed the staggering total of 44,672 lb – yet the estimated speed was 10 mph greater than the Handley Page, with ability to carry approximately one ton greater bomb load at an operational range about a third farther. The wiseacres shook their heads, but in war it seemed worth the gamble, and in the latter part of 1917 Tarrant had secured an order for two prototypes of his Tabor. By late summer of 1918 much of the basic construction of the first was complete, and had been taken to Farnborough's big airship shed for assembly.

Another triplane which had been initiated the previous November was



Powered by four Pumas in tandem as stop gap because engines of greater capacity were unavailable, the Bristol Braemar Mk I was flown to Martlesham on 13 September, 1918, and officially tested by Grahame-White's pre-war pilot Maj R. H. Carr, and Capt. C. Gathergood. (*A. R. Boeree.*)

the Bristol Braemar, but with just under 82 ft span it was a miniature compared with the Tabor and V/1500. Completed during the summer, the Bristol was flown by Fred Raynham, but four 230 hp Siddeley Pumas had to be temporarily used because the requisite 360 hp Rolls-Royce Eagle VIIIs were fully allocated for the V/1500 and D.H.4 production, and every possible 400 hp Liberty was required to meet Trenchard's urgent demands for more and more D.H.9As. Despite the apparent drag of its triplane arrangement and massive four-wheel undercarriage, the Braemar was surprisingly fast, proving much better than the H.P. O/400, and could similarly carry 5,000 lb total load, though most of it was fuel. Although it suffered heavy vibration, it was flown within a few weeks to Martlesham Heath for handling trials. Barnwell played a lesser part in the design, for he was busy on a two-seater replacement for the F.2B Fighter featuring single-bay N-strutted wings which, like the Westland Weasel, Sopwith Bulldog, and Kenworthy's Austin Greyhound, was to be powered with the A.B.C. Dragonfly. He had therefore delegated the Braemar conception to

Hallmarked with Farnborough design experience, Kenworthy's attractive Austin Greyhound replacement for the Bristol Fighter might have swept the board but for its A.B.C. Dragonfly. It was some 25 mph faster than the Bristol. (*G. Quick.*)

a team headed by W. T. Reid, who had made such interesting contribution to metal construction with the Bristol M.R.1.

Because of widespread engine development problems, the majority of aircraft prototypes received preliminary handling assessment fitted with temporary engines of far lower power, as exemplified by the Braemar. Usually the Bentley B.R.2 rotary was substituted for Dragonfly aircraft, but those intended for water-cooled engines had to make do with a BHP or Siddeley Puma. At least this enabled preliminary handling to be investigated, and in this way the D.H.10 was found so obviously promising that the second prototype had been fitted, despite short supply, with the envisaged twin 360 hp Rolls-Royce Eagle VIII installed as tractors instead of pushers for its first flight on 20 April.

Special twin Siddeley Pumas of 300 hp were to be installed in the Avro

Tractor 360 hp Rolls-Royce Eagle VIII engines were fitted to the second prototype D.H.10 Amiens Mk II which first flew on 20 April, 1918. (*de Havilland Aircraft*.)

Manchester to afford more direct comparison with the D.H.10, but they were not yet ready. The Sopwith Cobham built, like the Rhino two-seater and the little Snark monocoque fighter, to the still magical triplane formula, used similar high compression Pumas which were also designated for the new Nieuport triplane, being designed at Cricklewood by Henry Folland. As with the giant Tarrant, the Nieuport London showed marked structural originality, though in very different form because every item was designed, like Pemberton-Billing's long-forgotten 'Seven-Day Bus', for utmost simplicity of construction by carpenters. Of metal fittings there were few: many joints were made with nails and brass wire. Daringly, the fuselage was sheathed with $\frac{1}{4}$-in tongued and grooved match-boarding. Despite the uncompromising, angular arrangement of fuselage, square-cut wings, and tail surfaces, it revealed the unmistakable, characteristic hand of its designer.

Final version of the Avro twin-engined bombers was the well-proportioned Manchester. Prototype F3492 powered by Pumas first flew in December 1918 but was confusingly referred to as Mk. II.

On the Western Front the long tale of advance and capture continued. Philip Gibbs, of the *Daily Telegraph*, reported on 20 October: 'As I have written more than once in months past, the pilots and crews of our big Handley Page machines never leave Ostend alone, pouring bombs over the submarine workshops night after night, doing enormous damage; so that, as I can see by aerial photographs, many basins were abandoned, many great sheds destroyed, and submarines refitting or repairing had to creep farther back into other basins, which in turn are attacked. By day ordinary aircraft take up the work of the night raiders, dropping smaller bombs and keeping the German engineers in a state of terror.' Despite our relentless attack, U-boats managed to torpedo the Irish Mail-boat *Leinster*, and 400 passengers were killed or drowned. Again there was outcry, but it was offset by the successes of the fighting fronts.

The Handley Page O/400 was designed to carry the 1,650 lb block-buster of World War I, and with these they bombed Kaiserslautern and Wiesbaden on 26/27 October, 1918. On an earlier occasion forty O/400's had made a great night raid using 250 lb bombs.

'News from the Continental and Oriental war areas has been so satisfactory during the past few weeks that it seems well to review the situation in case a spirit of undue optimism should cause a slackening of effort on the part of those whose duty it is to see the war through to a victorious finish,' came the warning. But there was only qualified optimism. Influenza had spread like a plague. By the end of October people were dying like flies, and deaths in London alone were over 750 a week. Under the drab skies of October people went wearily, drearily, about their tasks, but as they stumbled along the pitch-dark streets they at least felt relief at absence of air raids since early summer. Yet even when the Austrians, on 3 November, accepted the terms imposed on them for Peace and made full surrender, there was widespread scepticism, as if this was another German trick to catch us out. 'The Austrian is a gentleman, though overridden and misled by the Prussian, and it seems quite possible that judicious diplomacy might cut Austria adrift from Germany,' wrote one commentator, confident that the stage was still being set for victory in 1919.

The American effort was getting into gear. On 1 November the *Daily Telegraph*'s US correspondent reported: 'The alleged virtual failure of America's aircraft production of six months ago has been replaced to-day by successful production which will rank high as a military achievement. To date, it is declared, America has built more aeroplanes of all kinds than were engaged last July on the Western Front on both sides. Some idea of the remarkable production may be obtained when it is considered that the Americans have built more engines this year than England built from the time she entered the war until the end of 1917, and the same is true of France. The USA built more aeroplanes this year than England did from 1914 to the end of 1916. Production has reached a point where supply is greater than cargo space available for transportation. America's aircraft programme has been carried out at a cost of £97 million, and there is a balance of £183 million still remaining which it is estimated will bring the total Liberty motor production to 50,000 if the war is prolonged, and will provide an equally overwhelming number of aeroplanes.'

There was a stir of interest on the 9th, when it was learned that the Kaiser had abdicated and escaped to Holland, yet people were almost incredulous when it was announced that the Germans were requesting safe conduct of a mission to discuss terms for an Armistice. Could it really be true? Could this four-year-long insanity really be ending? In truth, the whole German structure had collapsed in revolution. There had been mutiny at Kiel. Following the Russian lead, Soldiers' and Workmen's Committees had been formed, and the Red Flag was flying in Berlin. Just as the German Armistice terms to the Russians were those of absolute defeat, so were those of the Allies to the Germans who were required to surrender the bridgeheads of Cologne, Coblenz, and Mainz, and hand over 2,000 aeroplanes, particularly Fokker D.VIIs and night-bombers, 5,000 artillery guns, 30,000 machine-guns and small-arms, and the entire U-boat fleet together with their 10 battleships, 50 destroyers, six battle-cruisers, and eight light cruisers, which were to be immobilized in German bases specified by the Allies and the USA. In evacuating the Belgian coasts and ports, Germany must abandon all merchant ships, tugs, lighters, cranes, and harbour materials, all materials for canal navigation, all aircraft and air materials and stores, all arms and armaments, and every other kind of stores and apparatus. Finally: 'The duration of the Armistice is to be 36 days, with option to extend. During this period on failure of execution of any of the above clauses, the Armistice may be denounced by one of the contracted parties on 48 hours previous notice.'

The full terms were read to the German Armistice Commission by General Foch and Admiral Wemyss in a railway carriage at Rethondes in the forest of Compiègne; yet in the crazy pattern of all that war the fighting did not immediately cease. It took a few days for the new Republican Government to agree, and pass the signals round. Because of the vast Front in length and depth, men had to go on fighting and killing until zero hour at 11 o'clock on the morning of 11 November.

Among the sequence of official messages to his Army, Navy, and Ministers, the Rt Hon Lord Weir, Secretary of State and President of the Air Council, received the valedictory tribute:

> 'In this supreme hour of victory I send greetings and heartfelt congratulations to all ranks of the Royal Air Force. Our aircraft have been ever in the forefront of the battle; pilots and observers have consistently maintained the offensive throughout the everchanging fortunes of the day, and in the war zones our gallant dead have lain always beyond the enemy's lines or far out to sea. Our far-flung squadrons have flown over home waters and foreign seas, the Western and Italian battle lines, Rhineland, the mountains of Macedonia, Gallipoli, Palestine, the plains of Mesopotamia, the forests and swamps of East Africa, the North-West Frontier of India, and the deserts of Arabia, Sinai, and Darfur.
>
> 'The birth of the Royal Air Force, with its wonderful expansion and development, will ever remain one of the most remarkable achievements of the Great War. Everywhere, by God's help, officers, men and women of the Royal Air Force have splendidly maintained our just cause, and the value of their assistance to the Navy, the Army, and to Home Defence has been incalculable. For all the magnificent work, self-sacrifice and devotion to duty, I ask you on behalf of the Empire to thank them.
>
> November 11th 1918 GEORGE R.I.'

Even more than in other towns, the firing of maroons in London to signal suspension of hostilities had startling effect. Every factory downed tools. All over the city people poured into the streets, cheering and shouting. The day grew wilder and wilder, with great crowds in Trafalgar Square, and mobs drifting to and fro in Piccadilly, Oxford Street, Regent Street, and around Buckingham Palace. Flags were run out from every building. The whole country felt it had emerged into the brightness of day after long sojourn in darkness – and that night, for the first time in months and months, the lights went up again in reality in houses and shops, though street lamps still were shrouded. But many homes were too saddened by personal loss of husband, son, or relative to participate in the jubilation. Next day brought little feeling of victorious pride to anyone; only of relief, and sometimes even scepticism. 'One is by no means convinced that the war is yet over,' wrote C. G. Grey with shrewd conviction. 'There is still much political jiggery-pokery to follow before a definite Peace can be declared, even now that the Armistice is signed. If we can make a decent Peace with a stable German Government, as Lord Milner – apparently our only statesman – so wisely advised, all may be well. Yet if Red Flag socialism and anarchy and Bolshevism take hold in Germany as they have done in Russia, then we may well find ourselves only at the beginning of another war. We talk gaily of indemnities, and of making Germany pay for the war; but unless we make Peace with a stable Government we stand a precious poor chance of collecting our debts. If Bol-

shevism breaks up the German Empire then we and our Allies will have to wade into Germany and clear up the mess. And it will take a mighty big army to police a chaotic mass of some 80 millions of people when they are only unanimous in one idea – their hatred of the invader. If the real war stops forthwith, it means that all our futile politicians will be able to appeal to the stupid but honest electors of this country as being the men who have led them to victory. Thus they will, in all probability, be returned to Parliament with enhanced power – whereas, if the truth were known, people would realise that the British Army won the war in spite of, and not because of, its political mis-leaders.'

Lloyd George was certainly preparing to cash in. Arrangements for a general election were hurried forward with 500 candidates sanctioned by the Coalition leaders; but those without this blessing were libelled as a clique who had merely been interested in hindering the war. Labour was quite unrepentant and quickly defined this a 'coupon' election – but polling necessarily had to be rushed so that the newly elected political leaders – which Lloyd George determined would be the old ones – could go to the Peace Conference with the impress of mandatory confidence from the British Isles.

Capt B. C. Hucks started his career as mechanic to Grahame-White, tested Blackburn's early monoplanes, and was the first British pilot to emulate Pégoud's loops, and became Airco's chief pilot, shown here with a production D.H.9A.

Meanwhile the civilian population waited with almost apathetic frustration for the return of full freedom instead of directed employment and heavily rationed meals. Their underfed condition, and limited house-heating these foggy, damp November days, afforded no resistance to the great plague of influenza still sweeping the countryside. Only a few days before the Armistice, on 6 November, that great British pioneer pilot, Capt Bentfield Charles Hucks died in London from pneumonia following

influenza. When Pégoud introduced looping-the-loop, Benny Hucks became the first British pilot to emulate him. On the outbreak of war Hucks, like de Havilland and many another pioneer flyer, was called up by the RFC, and did a great deal of Service flying but he was persistently troubled with after effects of pleurisy, so was posted home for special duties, testing the series of D.H. machines. Always quietly confident of the correctness of his own opinion, though he never thrust it, Hucks remained the most likeable of men, quite unaffected by his fame.

8

The Minister of Munitions, in hope of avoiding mass unemployment, stated in a general notice to contractors and workpeople the manner in which production must be reduced:

> The great task before the country is the transformation of industry from war to peace. This necessarily involves disturbance and dislocation of industries and workshops. Very large numbers of workpeople will have to change their employment, and in many cases their present abode. In order that munition workers and their employers may at once be made aware of Government policy, the following instructions are hereby issued to all factories and firms engaged on work for the Ministry of Munitions:
>
> (i) There should, so far as possible, be no immediate general discharge of munition workers.
> (ii) All workers, however, who desire to withdraw from industry or to leave for any reason, and all workers who can be absorbed elsewhere, should be at once released.
> (iii) Production on contracts for guns and gun ammunition (etc.); aircraft and aero-engines; and the manufacture of explosives should be reduced in the following ways:
>
> (*a*) All overtime should be immediately abolished.
> (*b*) Systems of payment by results should be temporarily suspended, and cursory notice of the transfer from payment by results to time work should be given.
> (*c*) When a transfer to time work has taken place the reduction of the hourly week should, wherever possible, be introduced.
> (*d*) Whenever reduced hours of work are on a time-work basis, the number of hours worked must not be less than one half of the hours in the present normal working week of the establishment.
>
> To provide for the abnormal period following cessation of hostilities the Government have adopted as a temporary measure a general scheme of non-contributary unemployment donation, which has been laid before them by the Ministry of Reconstruction in agreement with the Ministry of Labour, on the following scale:
>
> (*a*) To unemployed men over the age of 18 years, 24s a week. To unemployed women over that age, 20s a week.
> (*b*) There will be an additional allowance in respect of the first dependent child under 15 years, 6s per week, and 3s for each additional dependent child under that age.

(*c*) There is provision for unemployed juveniles between the ages of 15 and 18 of 12s a week for boys and 10s for girls.

It is necessary that industry should be rapidly transformed to peace conditions in order to provide permanent and productive employment for the civil workers and for the fighting men returned from the war. The proposals outlined are solely intended to bridge over the inevitable period of dislocation.

An immediate exodus of workers from all factories began. Every aircraft manufacturer received substantial cancellation of contracts, though some, such as the Vimy airframes being built by Westland and Vickers, were retained as the nucleus of peace-time rearmament for the RAF.

Orders controlling demobilization were issued without delay – but it was obvious that there would be a long, long wait before the majority of enlisted men could return home. At the Royal Air Force aerodromes, whether at home or abroad, there was more a feeling of regret than of relief that the great days of flying were over. One of the Bristol Fighter pilots, W. F. J. Harvey, vividly recaptured his impression of that transient time: 'The sky of Northern France was very silent now. Sometimes, as they patrolled over groups of Germans moving back towards their homeland, imaginative pilots saw ghostly enemy formations in the distance; and, occupying the mess room of a German squadron, found it difficult to believe that they sat in safety on "the other side" over which they had so often flown in peril.

Aftermath of war. Beyond the Nieuport one of the giant Staaken R.XIVs stands wrecked by the Germans to prevent it falling into Allied hands. It had three tractor and two pusher 245 hp Benz engines. Power loading was 25·9 lb/hp and wing loading 8·8 lb/sq ft. All-up weight was 31,790 lb. (*Imperial War Museum.*)

'The rain-sodden countryside, the falling leaves of early winter, the miasmic atmosphere of four years of German occupation and the occasional expeditions in search of graves of squadron pilots and rear gunners long dead, formed a melancholy backcloth for those whose whole reason for existence appeared to have ended. Many – the majority – of those flying had been little more than children in 1914. They had grown up

expecting to join in due course the long procession of those who had disappeared or returned maimed. Suddenly they found themselves reprieved. They had experienced the extremities both of fear and of triumphant achievement, but these were to be no longer part of daily life. Now they found themselves out of step with their years, too old and too young, the future a blank.

'The case of the mechanics was different. Older on average, most had survived and were or had become skilled men. Their one thought was to go home and take up normal life again. It is a tribute to the squadron spirit that their conduct in the twilight between war and peace, disciplined service and demobilization, caused none of the anxiety experienced by many units.'

Meanwhile Lloyd George and his friends were, as *The Star* put it, 'making the world safe for bureaucracy'. On 22 November he and Bonar Law issued a Coalition Manifesto offering hope for a happier future but giving little evidence of concrete policy. On the eve of the poll, in his bid for a majority, Lloyd George was inspired to a headline and poster appeal demanding trial of the Kaiser and punishment for all Germans convicted of atrocities; indemnities from the enemy; rehabilitation for those broken by war; and a happy Britain for the British. It carried the vote: returns showed 478 Coalition members and 59 Labour, but the Liberals had polled only 27. The uneasy hurry was prelude to utter confusion of the careful plans for gradual, systematically balanced demobilization of industry and Services. Soldiers bitterly protested at delay in their release, and factory workers who had been established in pre-war days were demanding that all labour importees, particularly women who had taken men's jobs, should be swept out. Craftsmen were not only jealous of their rights, but apprehensive that the labour market would be flooded by millions of returning servicemen resulting in widespread unemployment.

Now was the time for reappraisal of the aircraft industry's future while slowing down its tremendous momentum. The lessons of aeronautical development must be assimilated and consolidated; the strategic use of military and naval aircraft applied to keeping peace in the world; the pathway to commercial aeroplane operation discovered and expanded into great routes across the earth.

The RAF had become the largest Air Force in the world, with 27,333 officers and 263,410 men of other ranks. The 103 aeroplanes and six airships possessed by the Military and Naval Air Services at the beginning of the war had increased to 22,647 aeroplanes and 103 airships, and operations were based on nearly 700 aerodromes and 184 front-line squadrons and 203 others. Loss by combat, crashes, and obsolescence had been 60 per cent, for 55,093 airframes had been manufactured in Great Britain during the war to which were added more than 3,000 purchased abroad. Such was the crescendo of production that the average monthly output of airframes had increased from 1,229 in 1917 to 2,668 in 1918, and equivalent engines from 980 to 1,841. Production by the

French aircraft industry had been even greater, and in particular achieved almost twice the number of engines that we did.

Yet in four years of bitter warfare, whether in daily dogged flying or spectacularly gallant combats, no more than 6,166 men of the British air Services were known to have been killed on active service on all the far-flung Fronts or fighting above the seas, though more than 3,200 were prisoners or reported missing. But if British airmen had been relatively lucky, world losses of mankind had been fantastic – with some eight million killed in fighting, and approaching 25 million who died because of the hardships and epidemics of those years. Millions more had suffered wounds, sometimes of ghastly proportion which must result in enforced seclusion for the rest of their lives.

The ending of war found the huge total of 347,102 men, women, and boys employed in the British aircraft industry, whereas the French officially had little more than half this number, and the Germans only 100,000 – but the latter figures possibly exclude component manufacturers. To regulate contractual and technical aspects of airframe and aero-engine manufacture the staff of the Department of Aircraft Production in the Ministry of Munitions totalled 17,250. Bureaucracy had a firm grip.

Everywhere there were great aircraft factories which soon would be vast empty halls. Retraction was inevitable.

As a preliminary but important step in reallocating labour forces and settling industry to peace-time conditions the Minister of Reconstruction appointed a number of bodies and committees to advise on the many aspects, including disposal of surplus government property. Aircraft came under the aegis of a committee comprising P. J. Pybus as chairman; R. O. Carey, of Sopwith Aviation; N. G. Gwynne, of Gwynnes Ltd; J. D. Siddeley, of Siddeley-Deasy; G. Holt Thomas, of Aircraft Manufacturing Co; and C. V. Allen, secretary of the Society of British Aircraft Constructors. While others were considering the best course to pursue, no time was being lost by Holt Thomas and Handley Page in making further active publicity moves towards use of civil transport aircraft.

In the course of an interview with the *Observer*, Holt Thomas said: 'Now that "Dora" allows me to speak, there is no harm in giving details of Capt de Havilland's designs, which have provided a large part of the British construction during the war and an enormous proportion of the planes for the American Flying Corps. In the last 18 months we have specialized on weight-carrying combined with high speed. The D.H.10, designed for long-distance bombing, will now be used for commercial purposes, carrying mails as well as passengers. I am just as enthusiastic over commercial transport as I was ten years ago over aircraft for military use; and although we have been compelled to devote ourselves to war purposes, it has not prevented us from making preliminary arrangements.

'The first point I have recognized in linking the world by aerial routes is that unfortunately British celestial rights apparently end in mid-Channel. It is therefore very unlikely that the French Government will allow an

all-British enterprise to run a Mail to Paris, or that the Italian Government will permit an all-British Mail to Rome, nor the Norwegian Government from Aberdeen to Stavanger. An aerial service between London and Paris must necessarily include rights of Franco-British capital, Franco-British aircraft construction, Franco-British pilots, and indeed an international combine in every detail.

'Facing these facts, I have started a company of national importance at Christiania for the purpose of joining up with my company Aircraft Transport and Travel Ltd,* which is under exactly the same direction as the Aircraft Company, and my other aviation enterprises. Similarly I have formed an allied company in France and another in Italy. I expect through Messrs Tata Ltd of India to link still further journeys from London, through France and Italy to India. Arrangements are also completed for a link through South Africa, from the Cape to Cairo.'

Frederick Handley Page was equally absorbed in the process of establishing his own airline company, and as a prelude, the replacement prototype V/1500, carrying 40 passengers and fuel for six hours, made a flight of 30 minutes in the hands of Clifford B. Prodger, during which a record height of 6,500 ft was attained. Handley Page somewhat ambiguously inferred to reporters that the machine would be used for his proposed London to Paris passenger service. 'The journey will take from 2½ to 3 hours and the fare will be approximately the same as the ordinary first-class ticket for train and steamboat. Fifty passengers will be carried and experiments are being conducted to silence the engine noise.' As a sign of his oft-quoted belief in aircraft transportation he had already registered the name Handley Page Transport Ltd. What he intended to use were O/400s which he would obtain under the proposed disposal arrangements initiated by the Minister of Reconstruction, for no more than three V/1500s had been completed. Even delivery of production O/400s had not begun until the spring of 1918, and only in the last three months of the war were they effectively getting into action in the hands of four squadrons; but in

*Aircraft Transport and Travel Ltd was formed on 5 October, 1916.

The production Handley Page V/1500 had greater tailplane gap than the prototype, and fins just aft of the front tail interplane struts to the rear spar, with rudders of the same chord as the elevators. Engine cowlings were discarded as this saved 500 lb weight. Christened Super-Handley, 255 of these V/1500s were ordered, but only three were available at the Armistice. (*S. T. A. Richards.*)

mid-September there had been sufficient of these splendid bombers to despatch a night force of 40 on German bases, though nine returned with engine trouble, one force-landed, and three were lost. Said the *Daily Telegraph*: 'There was general public expectation that Berlin would be bombed before the Armistice was signed. Everything was prepared, down to the detail of Thermos flasks. Nineteen huge Handley Pages were ready. The aviators chosen under General Trenchard's direction were among the most experienced on the Western Front. Trial flights with bombs weighing 1,650 lb had been made. The date fixed was November 9th, Lord Mayor's Show Day, but the weather conditions were wholly unfavourable. The flight was postponed until Monday the 11th. At 5 o'clock that morning the Armistice was signed – and Berlin was not bombed.'

While Handley Page and Holt Thomas were busy on civil aviation's preliminaries, Robert Blackburn, equally convinced of the expanding future for commercial flying, registered the North Sea Aerial Navigation Co Ltd, and proposed to use a cabin version of the Kangaroo – which despite superficial resemblance to the O/400 was considerably smaller and had nothing like the carrying capacity. Only ten had been delivered, but between May and November they had proved their worth in attacking U-boats.

9

Aware that without the war-time hothouse forcing of technical progress, official research programmes might be disastrously cut, the Society of British Aircraft Constructors began to implement activities, establishing two important technical committees respectively dealing with aircraft and aero-engine development. Their members significantly were key figures in each of those companies which they themselves had autonomously identified as the basic British aircraft industry. On behalf of the airframe producers they were Capt G. de Havilland, Aircraft Manufacturing Co; Capt F. S. Barnwell, British and Colonial Aeroplane Co; H. P. Martin, Martinsyde; F. Handley Page, Handley Page; A. V. Roe, A. V. Roe & Co; T. O. M. Sopwith, Sopwith Aviation Co; E. C. Gordon England, Frederick Sage & Co; O. Short, Short Brothers; R. A. Bruce, Westland Aircraft Works; J. D. North, Boulton and Paul; R. K. Pierson, Vickers; C. R. Fairey, Fairey Aviation Co; and Lieut-Col Mervyn O'Gorman, Aircraft Manufacturing Co. A pointed omission was the unobtrusive Robert Blackburn, but he was always a man to go his own quiet way, confident of eventual success.

The aero-engine committee had similar status, comprising: A. J. Rowledge, D. Napier & Son; L. J. le Mesurier, Sir W. G. Armstrong Whitworth & Co; F. R. Smith, Siddeley-Deasy Motor Car Co; A. H. R. Fedden, Cosmos Engineering Co; G. E. Bradshaw, A.B.C. Motors Ltd; Lieut-Col Mervyn O'Gorman, Aircraft Manufacturing Co; L. Coatalen, Sunbeam Motor-car Co; J. D. Pitt, Wolseley Motors; C. C. Elliott, Rolls-Royce; Lieut A. E. Bush, Daimler Co; and A. V. Dabbage, Austin

Motor Co. Nevertheless, aeroplane companies tended to regard engine manufacturers as mere sub-contractors, and it seemed unlikely that so many would be required for what must obviously become a greatly reduced airframe business.

In December, as earnest indication of concern for the future, appeared the Report of the Civil Aerial Transport Committee, which had been appointed in May 1917 to consider the extent to which 'trained personnel and aircraft which the conclusion of Peace may leave surplus to the requirements of the Naval and Military Air Services of the United Kingdom and Overseas Dominions' could be used, and the method of regulating civil aviation activities. Of the sixty Committee members only four were airframe manufacturers, and the others were a mixed bag of scientists, soldiers, and Dominion representatives, with Maj-Gen W. S. Brancker, AFC, representing the Air Ministry.

Based on the premise that each State owns its own air, the Committee stressed that it was urgent to approach Allied and friendly Governments to institute an International Aeronautical Convention. Their Report was divided into an introduction and five chapters, each of which dealt with the work of one of the five special committees, and 76 of the 83 pages were appendices. The exhaustive treatment in dealing with Government and Municipal control and civil legislation opined that the duty of regulating Air Transport should be assigned to the Air Ministry, and recommended issue of Certificates of Airworthiness and competency licensing of pilots, navigators, and ground engineers. Even C. G. Grey mildly approved pointing out that: 'What is wanted is an aerial Lloyd's, and we have practically such a thing in being in the Aeronautical Inspection Department led by General Bagnall-Wild. It is distinctly in the best interests of the aircraft industry that every aeroplane intended for public service or for hire by private persons should be compulsorily inspected not only when new, but at regular and frequent intervals.'

Though every aspect of air matters was subject to vital consideration these short December days, it was quite beyond the ken of the man in the street, for he was far more interested in the great display of captured German howitzers, field-guns, anti-aircraft guns, trench mortars, and machine-guns which lined London's Mall from end to end in close-packed ranks. High-spirited boys and curious men were free to pull levers and crank handles, scarce able to believe that this great collection of iron and steel so recently spat death at British soldiers.

But influenza was striking even more indiscriminately. On 13 December a brief notice appeared in the daily Press, stating that Major Herbert Frederick Wood, that dynamic, effective, and greatly disliked managing director of the Air Department of Vickers, had died three days earlier from meningitis following influenza. Whatever his critics might say, Bertie Wood had established one of the most important aircraft constructional enterprises in the country, building it up from the time in 1911 when he obtained a constructional licence for the French R.E.P. monoplane. The

country owed him a great debt for his action in 1914 of inducing his directors to lay down a batch of private venture F.B.5 pushers, thus enabling the RFC to have its only early fighter. Despite the great talent shown in the subsequent series of diverse prototypes, Vickers had been singularly unsuccessful until the advent of the Vimy recently designed by Rex Pierson, though the construction of more than 2,000 S.E.5as was the real index of the company's war-time value. Perhaps Major Wood had been too much the ex-Lancer officer, with trim moustache and military tailored clothes, to be regarded as more than a management symbol by the rank and file; yet C. G. Grey insisted he had such natural kindness that many a workman had been retained whom a harder master would have sacked. 'He had an astoundingly active mind, and was able to grasp a new idea and appreciate its military or aeronautical value with remarkable quickness. Even his enemies admit his energy, his mental activity, and his earnestness in whatever task occupied him at the moment.' Said one: 'True! – but he was impossible.'

The tall and debonair, very military Capt Peter Dyke Acland, who had been his chief assistant for some years, was appointed manager in his place. War-time Weybridge works continued under the control of Percy Maxwell Muller, with burly Archie Knight, that early Vickers School flying instructor, as his assistant. Those two were the great organizers and go-getters of production.

All too late the sixth Sopwith Snipe prototype, B9967 was flown early in April 1918 with a 320 hp A.B.C. Dragonfly, and achieved the outstanding speed of 156 mph. It was later partially developed under the name of Sopwith Dragon. (*Courtesy J. M. Bruce.*)

Their neighbour tenant from the opposite side of the aerodrome, 30-year-old T. O. M. Sopwith, who had become the most affluent and prolific of all British aircraft manufacturers, gave his views on commercial flying at a Press luncheon held at Kingston, but artlessly managed to comment that the newest Sopwith Snipe with A.B.C. engine had attained the immense speed of 156 mph, and could climb 10,000 ft in 4½ minutes with

full war load, including two guns. He did not add that this was only if the Dragonfly could be induced to run satisfactorily, for its life was still marginal. Whatever the merits of his fighters and their future, he held no optimistic view of the rapidity with which commercial aviation would become established, taking the practical but rather parochial attitude that fog would prove too serious an obstacle. Meanwhile he proposed to explore cautiously the possibilities of private flying and tourism, and would make a machine which would attempt the Atlantic flight piloted by Harry Hawker.

Press luncheons were becoming almost a fashion. The recently knighted Sir John Siddeley held one, and revealed that from a pre-war pay roll of 400 his company's had increased to between 5,000 and 6,000, and the factory area, where both aero-engines and aeroplanes were constructed, was some 1,250 per cent bigger than before. Of late, 200 Puma engines a week had been built, and the latest product 'the Siddeley Tiger 600 hp twelve-cylinder vee was bidding fair to challenge all rivals in the race for power'. He then disclosed that a big Siddeley biplane had been designed, intended for twin Tigers. 'Its design lends itself to the carriage of passengers instead of bombs with comparatively little modification, and the machine at present under construction has not got so far that the necessary changes cannot be carried out with comparative ease.' Nevertheless, he said it was not his present intention to proceed with aircraft and aero-engine manufacture after existing contracts were finished. Lest it had an effect on share values he refrained from directly indicating that the aeronautical design team would be transferred to a new company, Armstrong Siddeley Aircraft Ltd.

Concurrently, the Grahame-White Co of London Aerodrome announced they were 'prepared to devote a portion of their factories containing the most up-to-date machinery for metal and woodworking, and capable of a large output, to any work for which this plant is suitable'. It was yet another pointer of the awareness of all aircraft firms that they had been swept into far too big a size for peace-time requirements.

Unfortunately, Claude Grahame-White was at loggerheads with the Air Ministry over payments for cancelled contracts. He had been the victim of too many changes of mind by bureaucracy, first with a contract for V/1500s which was cancelled in favour of Sopwith Snipes, then Nieuport Nighthawks were substituted, and finally it became more Avro 504s which had just been cancelled. In desperation he wrote to his friend Winston Churchill:

> I can hardly imagine that within 10 days of the Armistice it can be the policy of the Ministry to cripple and render impotent an important aircraft factory which has been brought into existence and fostered by the Ministry. This suggested drastic action of discharging all our metal-shop hands will naturally have far reaching effect on the whole future of our important undertaking. It is indeed nothing short of driving us to ruin, and is bound to render it impossible to repay the £200,000 loan still outstanding provided by

the Treasury to enable us to construct a factory to carry out the contracts placed with us by various Government Departments – more especially as the whole of our remunerative aerodrome property is still in possession of the Government. With no warning whatsoever, and with no chance of seeking work elsewhere, I am driven to disperse an organization which it has taken four years to build up.

Although he appealed to have his case sympathetically treated, and to be assisted in the difficult transition between war and peace, he could get no help from Churchill except release of his company from government control. But this was not cash, and he considered that he had claims against the Government for £400,000 for cancelled contracts. Determined to fight both for this payment and compensation for the war-time use of Hendon aerodrome, he tried to gain time for his factory by reverting to his interest in cars, for in early years as Claude Grahame-White Co Ltd he had been an automobile dealer. In expectation of a great market for cheap vehicles he put into production a light-weight 3 hp single-cylinder, two-seat runabout; but sales were negligible because it seemed an inefficient toy. More astutely he bought from the Government every Silver Ghost Rolls-Royce chassis they would release, whether ambulance or armoured-car. After stripping and overhauling, they were fitted with luxurious touring or limousine bodies of his own design, and sold at prices approaching £6,000 each, making a tremendous profit.

An ambitious attempt at luxury transport was the Grahame-White Limousine with two Disposals 320 hp Rolls-Royce Eagle engines. Inevitably new construction of this size was too expensive, and after a mild crash the type was abandoned. (*Grahame-White.*)

This success made him all the more determined to retain his niche in the aircraft industry, and to that end he authorized his latest designer, the Frenchman M. Boudot, who had recently left Boulton and Paul, to produce an aero-limousine, powered by twin 320 hp Rolls-Royce Eagle vee engines, accommodating four passengers in an enclosed nose cabin giving a splendid vista, and the pilot raised in an open cockpit at the rear of the cabin. This seemed an ideal task because of his experience of twin-engine design with John North's resolute-looking P.7 fighter-bomber which was almost ready for flight, and had been named the Bourges.

Nationally there were more important things than making dispositions for the future of the aircraft industry. The future of the whole world was at stake. One result was a series of notables visiting London to discuss preliminary matters affecting peace with Germany. The first arrivals were France's President Clemenceau and General Foch, which gave Londoners the chance of seeing the man who at least nominally was responsible for winning the war. They were followed on 19 December by Haig and his Army Commanders, who were received by huge cheering crowds. Yet popular opinion welcomed President Wilson of the USA even more vociferously when he arrived with his wife on 26 December – for it was widely felt that it was his influence which had won the war, first by allowing shipment of American supplies, and then by destroying German morale with threat of vast hordes of fresh American troops dealing a decisive blow as soon as they arrived in France. But he remained something of an enigma. Only a few years earlier he had declared himself unable to judge on the cause and justice of the war; yet more than any other American in public service he had the background to do so, for until he retired from academic life in 1910 he had been a professor of American history and politics. His outlook was strongly pacific until elected President for a second term. Thereafter he took the lofty view that the USA was entering the war as a great free people wishing to end an intolerable European situation. With peace he became spokesman of the new age. The nations awaited his word. Many men had mooted establishment of a World League, and the idea caught his imagination as offering an ultimate Court of Appeal in international affairs. In this association, based on his knowledge of political science, he was preparing a document demanding open agreements between Nations and an end to secret diplomacy – with world disarmament as a major factor, freedom of commerce, and unrestricted navigation of the high seas.

Starved Germany, as though unaware of its imprisonment, was also making valiant efforts to readjust itself to peace. An Order was issued:

> The German Government advises the Soldiers' Council of the flying troops to transform the organization of the Aviation Service for War Aims into a Peace section under the name of the German Air Department. It will be the task of the latter to place itself at the service of the people on the lines of activities of trade, traffic, mail, food-stuff transport and guard duty.
>
> The address is: German Air Department, Charlottenburg, Suarez Street 31.
>
> Signed on behalf of the German Government
>
> Klapper. Pirner. Hildebrand.

The German aeronautical journal *Luftwaffe* struck the hopeful note: 'The German air weapon leaves the theatre of war unvanquished, lowers the war colours as a weapon in order to run the Peace flag up now, placing itself at the service of the peaceful occupation of the nation.

'The aeroplane is the international connection across seas and countries.

When every other means of transport fails, the aviator is the emergency help. Aeroplanes renewed the interrupted connection between Berlin and coastal cities. Foch sent the Armistice conditions by aircraft to Hindenburg.

'Every reader knows that our private express trains have completely stopped; only a few passenger trains are allowed among the goods trains, so transport is slow. Therefore it will readily be understood that the authorities use war aeroplanes for general purposes where necessary. According to the wish of the enemy we handed over 2,000 Fokker single-seat fighters and twin-engined bombers to him, but we still have the speedy, single-engined series aeroplanes of good load-carrying capacity and the giant multi-engined aircraft.'

Those aircraft the Germans retained were in many ways even more unique than British and French designs. All could now see that the process on both sides had been proliferation of types, whether fighters, reconnaissance machines or bombers, in hope of a slight edge in performance and capacity. Examination of German aircraft showed that for all practical purposes the current British machines had advantages which would afford superiority for a time; but German development had many daring features indicative of future leadership in technical design. Though their many types of great bomber were impressive, they were conventional; but the whole range of smaller aircraft revealed the beginning of change from biplanes to strut-braced or cantilever monoplanes of exceptionally small resistance. There were astounding numbers of prototypes. Particularly significant was the increasing metal construction, notably exemplified by the all-metal series of Junkers which were completely skinned with corrugated aluminium sheet. By contrast British construction was still firmly wedded to wood, but heading on conventional lines towards substituting built-up, high-tensile steel spars and other components for direct incorporation in the contemporary arrangement of wire-braced biplanes. Farnborough's pre-war embargo on monoplanes had left too deep an impression on Air Ministry technocrats, who had no real experience of commerce and ever-advancing science of aeronautical design, for them to be receptive of any great change.

An Allied Commission appointed to investigate German maritime and air activities reported: 'Warship and merchant ship inspections were completed at Wilhelmshaven in a couple of days, but visits to Air Stations on the North Sea took some time longer. Discipline and order were found much better at airship and seaplane stations than on warships, and at most of these every endeavour had been made to live up to the letter of the Armistice agreement.' The Norderney Seaplane Station was reported to compare most favourably with any of its kind in France or England, while the great Nordholz Zeppelin Station was undoubtedly the finest in the world. It was from there that practically all British-bound raiders started, and commission members were particularly interested to inspect the famous L.14 which had 24 visits to England as its score, and was practically

the only survivor of the original raiders. Nevertheless, the latest airships, such as the mighty L.71, outclassed it completely for power, speed, size, and stability.

Similar big rigid airships were viewed by many as the probable future rivals of transatlantic ships, with potential ability for voyages to such Empire outposts as India. Clearly the great expenditure entailed would not be feasible for some years, but it was tempting to consider whether German Zeppelins could be converted for such purpose.

Meanwhile demonstration of the aeroplane's long-range effectiveness had already been shown in July when Major A. S. C. MacLaren, MC, accompanied by Brig-Gen A. E. Borton, had flown a Handley Page O/400 to Palestine – and the machine was then used to carry supplies for Colonel T. E. Lawrence, and for Allenby's offensive, piloted by Capt Ross Smith. This same machine was next employed to fly Maj-Gen Geoffrey Salmond from Cairo to Damascus on 29 November, and thence by stages to Karachi and Delhi, the longest non-stop sector being 495 miles between Damascus and Baghdad which had taken 6 hr 53 min. Originally only intended as a tour of inspection of what was then called Mesopotamia, the Air Ministry decided, at Salmond's recommendation, that the flight should be extended to India.

It was followed by an almost disastrous flight to Karachi by a Handley Page V/1500, bearing the legend HMA *Old Carthusian*, which took off from Martlesham on 13 December, again piloted by Major MacLaren, and Capt Robert Halley, DFC, with Brig-Gen N. D. K. MacEwen as passenger. Cairo was reached on the 24th after trouble at Mersah Matruh, and on 30 December the machine force-landed at Ormara after the port rear propeller broke away in flight; but there was every intention of continuing next year.

Such auguries were significant not only to Frederick Handley Page, but to Maj-Gen Sefton Brancker, AFC, who had just resigned his post as Master General of Personnel to accept an appointment with Holt Thomas to develop his network of aerial transport. In other respects also, Holt Thomas was strengthening his team, for it now included Alfred Turner, who had been the effective 'headmaster' of the whole aircraft industry in his post as Director of Aeronautical Contracts at the War Office and later under the Air Board, but who now would conduct the financial affairs of the Airco empire. Lieut-Col Mervyn O'Gorman had long been snapped up as the architect of new schemes for Airco development, and with Geoffrey de Havilland as designer-in-chief, it seemed that there was going to be formidable leadership from this quarter. But Holt Thomas was becoming a sick man.

With excitement and apprehension, the whole aircraft industry was looking forward to what the first year of peace-time activities would bring,

CHAPTER IX
THE NEW DAWN
1919

> 'All future ages must applaud the abilities, and admire the cool, intrepid, determined conduct of these two men, who first crossed the Ocean suspended in the aethereal regions by the power only of inflammable air.'
>
> *Gentleman's Magazine* (1785)

1

Only meagre acknowledgment of the tremendous and triumphant part which the British aircraft industry played in the war had been accorded the pioneer manufacturers by appointing them to the lesser honours of the newly established Order of the British Empire. A few industrialists such as Samuel Waring, Herbert Austin, William Beardmore, and John Siddeley, who had converted their premises to shadow factories, were awarded a knighthood. In the New Year's Honours List the Royal Air Force did better, for the Services always enjoy more extensive recognition than their suppliers. Appointments as Knight Commander of the Order of the Bath were given to Maj-Gen W. S. Brancker for his war-time services; Maj-Gen F. H. Sykes as Chief of the Air Staff; and Maj-Gen J. M. 'Tails-up' Salmond, the G.O.C. of the RAF in France throughout 1918, who had earned his nickname as the result of a despatch he sent to the Air Council after the great German push in March 1918 had been stopped: 'All ranks have their tails well up.'

Lloyd George had promised that after the war Britain would be 'a land fit for heroes'. Men of all three Services, particularly the Army, were clamouring to return to England and proving more and more difficult to handle. They were not prepared to wait for releases dependent on the state of the labour market, but recognized only one criterion – that demobilization priority should be inversely proportioned to length of service and carried out at utmost speed. Early January brought riots in camps at Dover. The Government was forced to set up demobilization centres which soon were dealing with 50,000 exits a day. Although essential to maintain regiments of Occupation troops and active RAF squadrons for policing, overseas demobilization steadily continued, but as familiar faces made their farewells they were replaced each week by keen

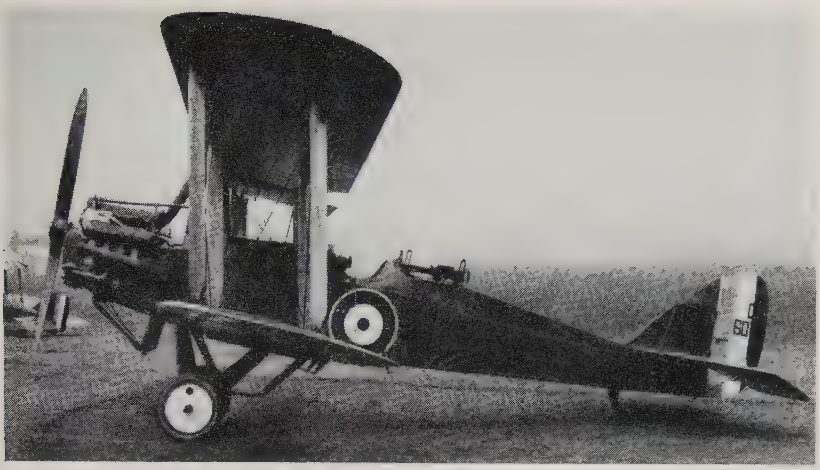
new entrants too young to join up until near the end of the war, and who in the case of the RAF had only completed initial training as pilots, observers, mechanics, and armourers.

On 10 January the Ministry of Reconstruction was placed under the direction of Sir Auckland Geddes to plan a more generous social order with better conditions of employment, education, and housing – war-time building having ceased except for repair, resulting in a shortage variously estimated as anything up to a million. Meanwhile other Ministries were overladen with staff. Yet it was expedient to run the numbers down slowly, except for those with immediate civilian jobs available, otherwise competition against non-Governmental wage earners for jobs would lead to further distress. In the process of streamlining, the Air Ministry was combined with the Secretaryship of State for War, and the Ministry of Munitions recategorized as Ministry of Supply. Churchill went to the War Office, and Sir F. E. Smith became Lord Chancellor.

On the Continent our late enemies were starving. Relief food supplies on enormous scale were essential for Germany, Austria and Hungary. America took immediate lead, sending 1,500,000 tons of foodstuffs for free distribution to give breathing space until next harvest. She could well afford to do so, for her people had suffered little by comparison with any European state, and in supplying munitions and equipment at tremendous cost to the Allies had put Europe stupendously in debt. Britain, exhausted by the long struggle and the drain on her finances, could make little contribution to famine relief, nor had the will to do much more than struggle with her own problems.

Finance had become of overwhelming importance to British aircraft manufacturers as it would dictate closure or survival. Factories had been extended again and again to cope with war-time demand, but now companies faced cancelled contracts in every direction. Certainly Handley Page and Holt Thomas were determined they would lead the way into prosperous civil aircraft operations, but Tom Sopwith more cautiously hoped for continuance of military fighter orders, supplemented by limited production of private aircraft in expectation that the thousands of pilots trained in the last few years would yield a fair number able to continue their flying as a hobby. It was an optimism to which every war-time designer clung, whether long-established pioneer or relative newcomer.

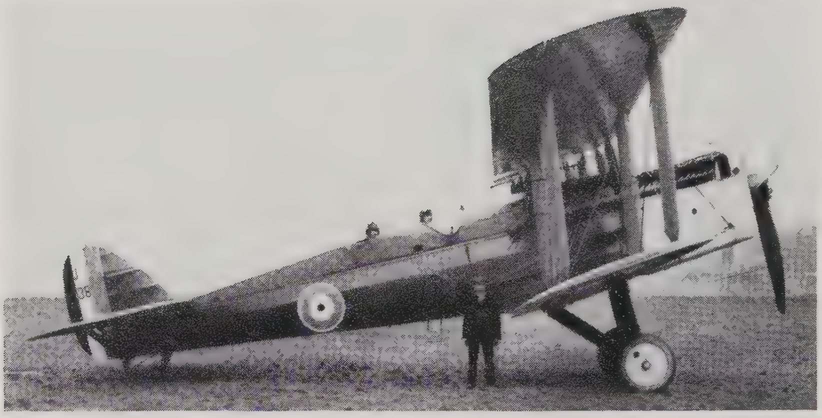
The year opened auspiciously for Holt Thomas, for on 2 January Capt Andrew Lang, RAF, with Lieut A. W. Blowes as observer, climbed an experimental D.H.9 fitted with the first production Napier Lion broad-arrow to 30,500 ft, gaining a world record. Initially using a prototype Lion, this machine had been used by the RAE to ensure proper functioning of engine and retractable radiator, and adequate heating of the induction system. Performance proved so promising that an early decision was taken to attempt spectacular records when the earliest production engine became available, for although the power was originally envisaged as 300 bhp at 10,000 ft it now gave 430 hp.



Promising high-altitude experimental work carried out at Farnborough with a prototype Napier Lion in a D.H.9 led to a 30,500 ft height record established with a production engine, giving valuable publicity for Airco and Napiers. (*Imperial War Museum.*)

Andrew Lang was an Australian. He told reporters that he and his Canadian observer had trained as strict teetotallers and gave up smoking – for nobody was certain of the effect of high altitude on the body. They wore special electrically heated suits derived from the 'Sidcot' devised a few years earlier by Capt Sidney Cotton, RFC, who had padded a mechanic's oversize overall which became the new pattern of standard clothing because of its greater freedom of movement and warmth compared with the long leather coats worn at that time by air crews. Said Lang: 'During the first 8,000 ft the machine tossed about like a leaf, but afterwards settled down to more comfortable flying. We climbed in big circles, but were blown out of our course, and when nearly six miles up were about 25 miles out at sea off Yarmouth. At 20,000 ft the cable in the rev counter broke, and at 28,000 ft I felt a shortage of oxygen so signalled for more. I then found Lieut Blowes was unconscious and had been so, as I afterwards discovered, since 20,000 ft. I managed to hang on till 30,500, when the fuel pressure pumps ceased work owing to rarefication, and the engine stopped.' For the first time on record 70 degrees of frost was registered at ceiling, with resultant frost-bite on hands and face, Blowes, who was only 19, suffering particularly. Thereafter it was reported that Lang had been placed under open arrest for communicating with the Press.

Napiers had suffered the usual vicissitudes of developing a new and complex mechanism. The directors had at first been chary of embarking on the engine, but as Montague Napier had offered to develop it at his own expense this at least gave them faith. But now Napier was a sick man, spending most of his time in the warmer climate of France. Although no longer a controlling shareholder he still strongly influenced the company's policy, and like his great competitor, Henry Royce, was the



Last of the Airco war-time designs was the big D.H. 14 day bomber of $50\frac{1}{2}$ ft span and 7,014 lb all-up weight, powered by the new Rolls-Royce Condor which had been type-tested at 525 hp but did not become available until early 1919. (*Imperial War Museum.*)

inspirer of much design work – though it was his chief engineer, A. J. Rowledge, who made so triumphant a success of the twelve-cylinder three-bank principle. As a result, the end of the war found the firm with a contract for initial production of 100 Lions.

Success of the high-flying D.H.9 was giving Napiers second thoughts on the possibility of staying in the aircraft industry, though recently H. T. Vane, the managing director, aided by Rowledge, had been endeavouring to persuade Montague Napier that it would be better to get back into the car business with a six-cylinder car which would compete with the Rolls. Napier had his doubts: it was the dawning day of mass-produced vehicles typified by the Ford, cutting the chance of success with a high-class car. A wise policy would be to retain a second string: now that the big Lion had achieved such resounding record, Napier was even more convinced that his firm must remain in the aero-engine business, and that aircraft designers would clamour for such power. The need was instanced by de Havilland who had recently designed an impressively large clean military biplane, the D.H.14, for which a single Rolls Condor was intended. Although envisaged as a replacement for the D.H.9, de Havilland realized that here was the basis of a splendid cabin transport powered by a Napier Lion. He was unaware that his preliminary scheme showed marked similarity to a commercial biplane which Koolhoven had commenced designing immediately the Armistice was announced, aiming at comfortable cabin accommodation for four passengers, and with the pilot halfway between cabin and tail in an open cockpit. The Dutchman's adroit manner so successfully convinced Lord Waring of future possibilities in commercial aviation that he gained permission both to build this machine at the B.A.T. works in Willesden, and to continue promoting his Bantam and recent Basilisk fighter designs. Not far away at Kilburn, Tony

This B.A.T. Basilisk F.K.25 was the first prototype with plain ailerons, but those of the second were horn-balanced. Early Martlesham tests had anomalies in speed recording, but it is probable that performance was similar to that of the Sopwith Snipe with Dragonfly engine, though the Basilisk was considerably smaller. It was of similar size to the Bantam, representing a more practicable redesign as a two-gun fighter. (*Imperial War Museum.*)

Fletcher as manager had induced R. G. Cattle, owner of the Central Aircraft Co Ltd, to advertise a side-by-side two-seat sporting biplane based on the trainers he had designed for Martinsyde and the London & Provincial Flying School at Stag Lane. This led to the design and construction of a twin-engined passenger carrier of modest useful load, as well as production of an angular instructional and touring machine having the appearance of a D.H.6.

Government circles were feeling the wind of change no less than civilian

Late in 1916 the woodworking firm of R. Cattle Ltd formed the Central Aircraft Company with Tony Fletcher as manager. Immediately the war ended he initiated civil designs of which the first built was the Centaur IV, a simplified angular version of his Martinsyde and London & Provincial trainers.

businesses. On 11 January it was announced that Maj-Gen the Rt Hon J. E. B. Seely, CB, CMG, DSO, MP, until recently Deputy Minister of Munitions, had been appointed Under-Secretary of State for Air. Although acknowledging General Seely as a very brave man, *The Aeroplane*'s editor could find no other good to say, and took malicious pleasure in telling his readers that before the war 'Seely was convicted in the House by Joynson-Hicks of uttering amazing falsehoods concerning the strength of the RFC, and subsequently as War Minister in 1914 was broken over the Ulster affair, where his alleged mendacity seemed even greater than his falsehoods concerning the RFC.

'It was hoped that Mr Winston Churchill would be Lord Weir's successor at the Air Ministry if he did not take Office as First Lord of the Admiralty. Instead he has been appointed Secretary of State for the War Office and Air Ministry combined. This is in accordance with Mr Churchill's belief – shared by many competent statesmen – that there should be a Ministry of War, which would combine the Ministries for the Navy, Army, and Air Force, each in charge of an Under-Secretary. In this way the best brains of all three Services would be available for organization of combined strategy and tactics, instead of carrying on disjointed and frequently objectless operations as in this last war.

'But how this co-department to the War Office is going to control civil aerial transport is not easily comprehensible. It is as if the Royal Army Service Corps were suddenly to become the paramount authority over all motoring. The better way would be for the War Office to take over all Army aviation and leave the Air Ministry purely as a civilian authority.'

2

Just as in 1913 Major F. H. Sykes had given a far-seeing exposition of the use of aviation in warfare, so now as Maj-Gen Sir Frederick Sykes he comprehensively pictured *Commercial Aviation in the Light of War Experience* at a meeting convened by the London Chamber of Commerce. 'Aviation in any form is but a dozen years old,' he said. 'It is a fact we are apt to forget until reminded of it by some such event as the recent laying of the foundation of a statue at Le Mans to Wilbur Wright, whose efforts and patient work culminated in mastery of the air. There is something both striking and prophetic in the perfect sequence of events when we consider that the problem of flight has been solved just in time to render not only the great part aviation has played in the struggle and victory we have just achieved, but also to profit by the incredible impetus which the stress of war has given to its development. So it comes about that, in most countries, aviation is to-day a child of war and a military development pure and simple.'

He then analysed the value of aircraft in peace-time, stressing that public confidence in the safety and security of flying must be engendered so that aviation could take its proper place in relation to older transport. 'A policy of "safety" must prevail, and the aerial "Plimsoll line" and the "A1

Maj-Gen. Sir Frederick Sykes, CMG, (right) in 1912 became the RFC's first commander. He was succeeded in 1915 by Maj-Gen Sir Hugh Trenchard, DSO, (centre) who was one of the founders of CFS. Maj-Gen. John Edward Bernard Seely, DSO (left), was appointed Under-Secretary of State for Air in 1919. (*Flight Photos.*)

at Lloyd's" must brand every British aircraft with the hallmark of quality and security.'

Ranging widely over every aspect affecting civilian use of aircraft, Sykes made it clear that although fighting had ceased, we were still at war. Private and domestic legislation depended for its character on the findings of the International Conference, but the Air Ministry had drafted a preliminary set of regulations to avoid delaying commencement of private flying, and it was hoped this would come into force during the first few weeks of the new Parliament.

'This brings me naturally to the subject of some of the competitions which have been discussed, and particularly to the magnificent *Daily Mail* offer of £10,000 for the transatlantic flight. With enactment of these interim regulations this flight will, as far as Great Britain is concerned, be open to all comers, including our friends in America. The flight has long been under consideration at the Air Ministry – not of course, with a view to the prize – and last June arrangements were commenced with a view to testing the possibility of bringing aerial reinforcements from America to help win the war.'

From a description of the serious weather problems which affected Atlantic flying he turned to such important routes as England to India; Cape to Cairo; European services and short-haul routes at home, revealing that the RAF had already been active on the Paris and Brussels routes. 'We had two Flights of D.H.4s, with Rolls-Royce engines, and a few other machines, with a personnel of 61 officers and men. Between August and November last no fewer than 279 passenger cross-country flights were made, with not a single crash to any machine with passengers on board. Many distinguished people were transported, including several members of British, French, American, and Dominion Governments. Also 131 visiting machines were received and attended to. Another organization

With the Armistice came necessity of urgent courier service between London and Paris, so four RAF D.H.4s each had the gunners' cockpit modified to form a small two-seat cabin and the top wings were rigged slightly back for trim. (*Crown copyright reserved.*)

which the RAF found necessary has been a Channel ferry from Lympne to Marquise. During the four months July, August, September, October, 227 trips were made and 1,843 passengers transported. Of the 123 days in those months, cross-Channel flying was possible on 71 days, or approximately 60 per cent.'

Seaplanes, he considered, could not be operated with the regularity and ease of land-based aircraft, and their disadvantages were intensified if unable to operate from a good harbour. On the other hand airships, although still in embryonic stage, might be particularly well adapted for long-distance journeys as there was practically no limit to range provided the vessel was large enough, and the expense of constructing large housing sheds might be avoided by using mooring masts such as those experimented with at Cardington.

Describing requirements for organization of weather information, Sykes said that there were 31 RAF Meteorological Stations in the UK alone, and stressed that night-flying increased the difficulties of the indispensable aerial navigator, so emphasis must be placed on directional wireless telegraphy. 'It is, to my mind, essential that the development of both meteorology and wireless should take place along broad imperial lines. British aircraft will then soon be as widely spread as the British Empire.'

The day after Sykes's masterly analysis of the operational constituents of commercial aviation, Frederick Handley Page, under the banner of the Royal Aeronautical Society, was no less adroitly explaining to a large audience in the Central Hall, Westminster, the value of long-distance flying – particularly when undertaken by a Handley Page aeroplane. As examples he quoted the flight by an O/100 from Hendon to Constantinople to bomb the *Goeben*, and the O/400 to India, but cautiously hid the fact that the V/1500 *Old Carthusian* had not yet reached Karachi. That goal was only attained on 16 January at the last gasp with the two rear engines out of action. Undoubtedly H.P. would use this news as indicating the value of four engines.

On 17 January the 41-year-old Marquess of Londonderry was announced as Financial Secretary to the Air Ministry and representing them in the Lords. On all sides the appointment was received with satisfaction, for the 7th Marquess, owner of great estates in Ireland, had already distinguished himself as the representative of Ulster opinion during the Irish Convention. Ireland remained a thorn in the flesh. When Parliament met, hardly an Irish member was present, for Nationalist seats had been taken by Sinn Feiners, who absented in a body because they were holding a Republican Convention in Dublin. In France, Irishmen and Englishmen and Scotsmen had died side by side: now Ireland was a rebel country forcibly held. The seriousness of what was brewing could not be realized; yet equally it did not seem particularly significant when the Labour Party in Britain announced that as Liberalism had collapsed they considered themselves the official Opposition, even though only 59 strong.

Now that there was time for calm assessment of the aeronautical development of the last four years, it was clear this was not so great as many claimed. Certainly structural 'engineering by eye' had been replaced by precise methods of mathematical calculation; stability had been put on a firmer basis; and controllability had become less a matter of luck than wind-tunnel diagnosis. Design improvement resolved into the difference between contemporary fast and powerful aeroplanes carrying a mere 7 lb/hp, and the slow machines of four years earlier coping with 17 lb/hp by employing light wing loading. Basic structures remained in essence the conventional type already achieved by the time war started, comprising four longitudinal members with spacer struts appropriately tie braced to form a rectangular girder, whether applied to fuselages or biplane wings. Even the recent trend towards monocoque fuselage construction, exemplified by the Sopwith Snail and the B.A.T. fighters, had been foreshadowed by de Havilland's pre-war B.S.1, and revived because of German success with this method. But in Britain it was abandoned because it was quicker and cheaper to mass produce girder fuselages. Even enormous research on aerofoil sections had not led to anything like the bold steps the Germans had taken in developing deep cantilever wing-sections with bluntly rounded noses. One more year of war would have shown the Germans to have undisputed technical leadership.

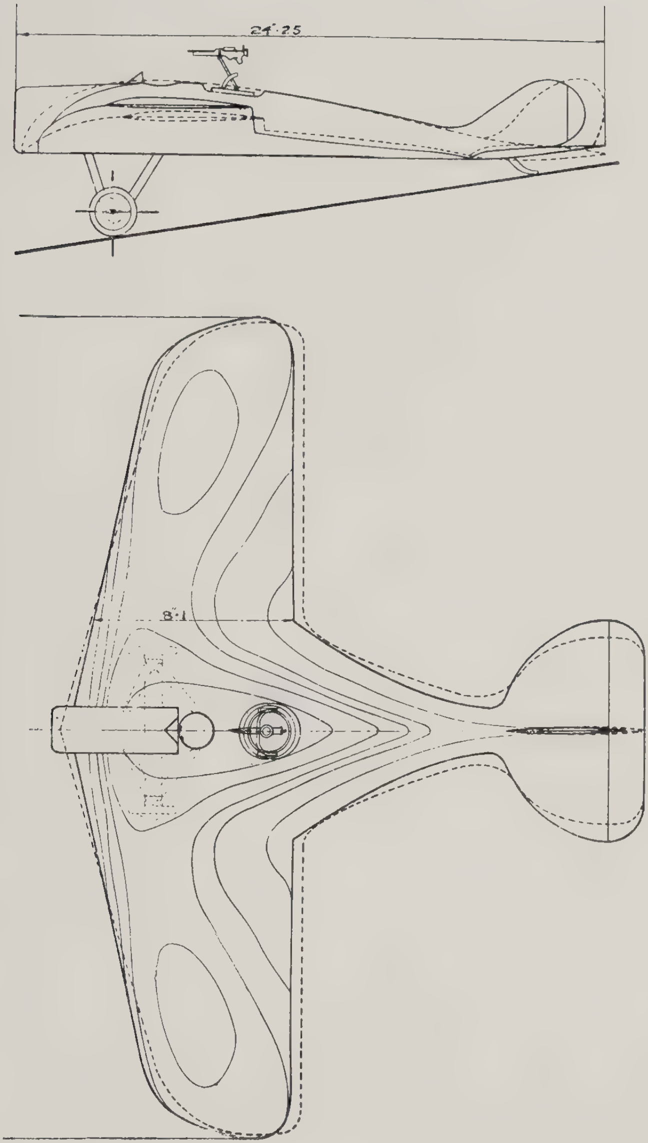
What caused English and French designers to rely for improvement only on the succession of power increases provided by later and later engines? Was it merely the British attitude of compromise? Had there been an official clamp on *ad hoc* research? If a design philosophy worked well, was that enough? Undoubtedly our native genius had built into British aircraft distinctly individual characteristics of strength, stability, and control which often gave handling and manoeuvring advantage compared with their opponents. But primarily it was with the Rolls-Royce engines and Bentley's B.R.2 that Britain had achieved commanding superiority in reliability, power for weight, and engineering perfection – and this characteristic might well prove the key to the value of Britain's

future contribution to air supremacy, for the Cosmos and Siddeley radials and the powerful water-cooled Lion held similar promise.

The fundamental direction of development, whether engines or air-frames, was the responsibility of the select group of scientists and officials who directed the Aeronautical Research Committee. If they were hide-bound in outlook, then the practical engineers in the leading aircraft companies would be constrained to less imaginative proposals than they deemed feasible. Certainly R & M 571, issued in January, indicated that the official mind countenanced vistas of far horizons, for here were revealed tests on two model cantilever monoplanes, known as Woyavodski, in which comparative measurements were made of lift and drag at 40 ft/sec. This was the design which Wilkins of the Aircraft Manufacturing Co had discovered in Russia when establishing a factory for construction of the D.H.4. Here was a well-streamlined low-winger which seemed a big advance on contemporary Allied aircraft, matching the new German monoplanes. Farnborough confirmed large maximum lift, but unfortunately accompanied by increased drag, resulting in an L/D of only 10·8, or no better than the S.E.5 as a typical fast scout. If an external undercarriage was added instead of the retracting one which Woyavodski proposed, the L/D decreased to as little as 5·48 at maximum flying speed. Nevertheless in view of the direction in which German design had been moving it seemed to British Air Ministry officials probably worth building a full-scale machine, but with the heavy contractual cut-backs currently being made it was not expedient to embark on such work at the moment other than give Harold Bolas the bait of a design study at Parnalls.

Despite official retrenchment in military aviation requirements it happened that Great Britain was one of the few countries legally free to embark on aircraft production, for the Compagnie Générale de Navigation Aérienne, possessor of the Wrights' fundamental aeronautical patents in France, re-opened its action, begun before the war, against all French aeroplane manufacturers because they used warping or aileron derivatives for lateral control. A bailiff, with attendant police, visited various prominent aircraft works near Paris, and officially seized every aeroplane. Compensation for infringement was estimated at £1,200,000. But in Great Britain, thanks to the action of Griffith Brewer at the beginning of the war, the Government had already compensated the Wright company for the use of such patents, and the British aircraft industry was free to use ailerons without further royalties.

The enormous amount of aircraft *matériel* which the RAF had in excess of needs was a danger signal troubling every manufacturer. They would like to have seen all destroyed, but the Government could not countenance such glaring waste of public money and proposed disposing of this millstone surplus for what they could get. To that end a special Salvage Department, controlled by the Technical Department of the Department of Aircraft Production, was placed in charge of Lieut-Col Darby, RAF. Existing aircraft reception depots were diverted to salvage operations,



Proposals for a clean low-wing fighter monoplane with wing contours blending into the fuselage were tried in model form at Farnborough, and Harold Bolas prepared a design study but for the time being no further action was taken.

where all airframes and engines fit for use were carefully stored. Those needing repair were sent to one of the government established national aircraft factories to be broken down into main components and all serviceable parts saved, cleaned, painted, and stored. Even the linen fabric was cleansed of dope, the cellulose acetate recovered, and the clean material sold for manufacture of fine paper. Thousand upon thousand steel fittings were sold as scrap, and non-ferrous materials melted down for sale in ingot form. The end result was some 5,000 serviceable aeroplanes for disposal – such as D.H.4s, D.H.6s, D.H.9s, Avros, and even Handley Page O/400s. Of aero-engines there were 10,000 ranging from the reliable old 120 hp Beardmore to the later BHP, Hispano-Suiza, Rolls-Royce Eagle, and innumerable Clergets, but all recent marks of engine were retained. The Government hoped there was a big field of export not only in Europe but in the Far East and South America, though optimism was somewhat tempered when it was found the French were vigorously preparing to sell their surplus in similar manner.

Of the knock to production of new machines which were the life-blood of the industry a commentator said: 'The British manufacturer holds his future reputation abroad in his own hands. Whether he will buy up his own war-time machines, renovate them, and himself deal with this very large market now open, or whether he will allow his name to be associated with a job lot of aircraft no longer needed by the RAF, and disposed by it at more or less bargain rates, is largely for him to decide. It is to be feared that in many cases the necessary capital for embarking on the first course is not immediately available, but one would unhesitatingly recommend such a scheme as much sounder and more immediately profitable than any attempt at quantity production of new machines for commercial purposes.

'Even beyond these more or less direct openings there is a wide field for initiative and resource in utilization of spare parts and fittings for purposes other than those originally destined. There are, for instance, thousands of complete cylinders, valves, pistons, connecting rods, timing gear wheels, oil and water pumps and the like, that will never be needed in the life of the complete engine to which they correspond, and the enterprising engineer who will design a crankcase and crankshaft to suit the ready made parts available, will find himself in a position to put upon the market a car, boat, or country house lighting engine of almost any output required, at very low initial cost and in a much shorter time than required to organize complete manufacture of such a product.' It was a point which did not immediately strike root, but it had potentiality which lingered in the mind of Geoffrey de Havilland.

3

Like all war-time producers, the directors of every aircraft company were facing large demands for Excess Profit Duty. A financial expert of the day affirmed that the EPD contributed greatly to currency inflation which was the cause, directly or indirectly, of so much trouble in relating cost of

labour and had produced wild visions of the millennium of high wages and minimum work.

Oswald Short told me: 'In the four war years ending in 1918 we made a gross profit of £501,219, of which very little was liquid because we had spent a great deal of money in enlarging the works and the means of production. Our profits for the year 1 September, 1913, to 31 August, 1914, were some £12,000, but for three years we had not had our accounts audited. Yet although war had broken out on 4 August the whole 1913–1914 account was treated as a war year and we were called upon to pay 50 per cent of the £12,000 profit, and for the rest of the war years on the same basis.'

The Aircraft Manufacturing Co, which was vast compared with Short Bros, proportionately made far greater profit, which even after payment of tax was about the same as Shorts' gross profit. Airco's capital investment increased from £5,250 in 1914 to £402,500 in 1918/19, and tax paid profits correspondingly increased from £22,256 in 1913/14 to a peak of £176,701 in 1917/18 – but though at that point the capital was almost treble it was currently clear that profit for 1918/19 would show a big drop because of the peace-time recession.

Production at the Airco factories had increased by leaps and bounds throughout the war: August 1914 to May 1915: 530 airframes and 141 engines; June 1915 to February 1917: 7,137 airframes and 8,917 engines; March 1917 to December 1917: 13,521 aircraft and 13,979 engines; and January 1918 to October 1918: 26,685 airframes and 29,561 engines.

By the end of the war the parent firm and its many sub-contractors produced more than 3,000 aircraft and 3,000 engines each month. From Airco itself one airframe was completed every 45 minutes. Peace-time conditions left an enormous void, and Holt Thomas was a very worried man. But what of the extensive Sopwith factory, the great Manchester shops of A. V. Roe, the huge Bristol establishment, the splendid facilities which Handley Page had at Cricklewood? Was disaster staring them all in the face? Would there be military orders?

On Wednesday, 12 February, the peace-time reorganization of the Royal Air Force was announced on a basis which opened a brighter prospect than any had expected. *The Gazette* stated:

> The following appointments have been submitted to the King by the Secretary of State for the Royal Air Force, with the consent of the Prime Minister, and have been approved by His Majesty:
>
> Major-General Sir H. M. Trenchard, KCB, DSO, to be Chief of the Air Staff.
>
> Major-General Sir F. H. Sykes, KCB, CMG, to be Controller-General of Civil Aviation.
>
> Major-General E. L. Ellington, CB, CMG, to be Director-General of Aircraft Production and Research.
>
> In order to provide for the control of Civil Aviation it will be necessary to alter the constitution of the Air Council as established by the Air Constitution

Act 1917, and legislation to enable that alteration to be made and to provide temporarily for the control of Civil Aviation in general accordance with the recommendation of the Civil Aerial Transport Committee will shortly be introduced into Parliament. Pending the passing of that legislation Major-General Sir F. H. Sykes will be responsible to the Secretary of State, after which he will join the Council.

The Air Council was constituted with Winston Churchill as President and Seely as his deputy; others were Sir Hugh Trenchard, Sir Frederick Sykes, Maj-Gen Ellington, the Marquess of Londonderry, Sir John Hunter (Works and Buildings), Sir Arthur Duckham, Sir James Stevenson (Army Council), Brig-Gen Alexander (Munitions). Maj-Gen Sir Godfrey Paine was made Inspector General without seat on the Council; Brig-Gen R. M. Groves became Deputy Chief of Air Staff, and Rear Adml C. S. Lambert was Director of Personnel.

Gleefully C. G. Grey reported: 'General Trenchard's return to a place of power has been expected ever since the storm raised by his resignation resulted in the abrupt departure of Lord Rothermere who "resigned" him. There are some people who are inevitably predestined to influence progress in certain walks of life, and Sir Hugh Trenchard is an essential factor in Service aeronautics. So universally approved is the appointment that even the *Morning Post* has failed to find in it any cause for an attack on Mr Churchill.

'In his speech on the Amendment to the Address in Parliament on February 12, Mr Churchill conveyed the idea that the RAF of the future would merely have to be sufficiently adequate for the needs of the Navy and Army. He made no reference to building up an enormous Air Force, such as is essential to the defence of this country and to the offensive against our enemies in future wars. Sir Hugh is faced with the old familiar task of the British Army officer – making bricks without straw. Fortunately he already has experience of this. He did it at the Central Flying School in 1912. He did it at Farnborough in 1914. He did it with the RFC in the Field in 1915. And he did it with the Independent Force of the RAF in 1918. In every case he accomplished the impossible. He enters upon his arduous task assured of the personal devotion of everybody in the RAF.'

In many ways Sir Frederick Sykes would have made a splendid Director-General of Aircraft Production and Research, and there was some surprise that Maj-Gen Ellington had been posted to this position. C. G. Grey made the pertinent comment: 'Personally one regards the fact that he is not a technical man and has had comparatively little to do with practical flying as high qualification for his particular post. Most of the ills from which the Flying Services have suffered have arisen because heads of various Ministry departments have fancied themselves as technical or practical men, and insisted on pushing their pet ideas down the throats of designers and constructors instead of sitting in calm unprejudiced judgment and selecting what was proved on test to be best.' Indeed, the management

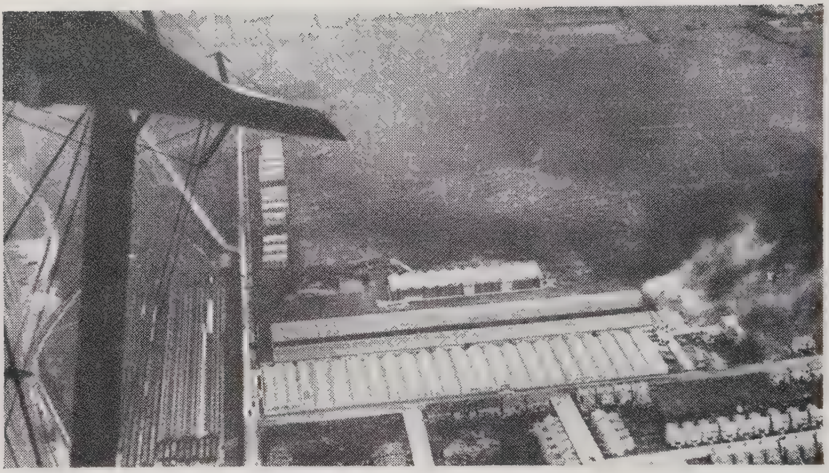
and designers of the major aircraft companies saw in Ellington's appointment considerable hope, for he had earned high reputation for integrity and balanced judgment, and it was realized that he would introduce a calm judicial atmosphere into the hitherto chaotic departments which he now controlled.

Undoubtedly a powerful Air Council had been created which gave every hope of success both for the RAF and to civil aviation 'within the limits imposed by an impoverished Treasury and a pacifist Government'.

Certainly the Government was facing great problems. At the Peace Conference, opened on 3 February, President Wilson was holding the stage. 'Never before were nations so eager to follow a Moses who would take them to the long promised land where wars are prohibited and blockades unknown,' scathingly wrote H. G. Wells. 'In a little while one discovered that Wilson, the hope of mankind, had vanished, and that all the illustrated fashion papers contained pictures of a delighted tourist and his wife grouped smilingly with crowned heads and such-like enviable company. The men he had chiefly to deal with were M. Clemenceau of France, Mr Lloyd George and Mr Balfour for Britain, Baron Sonnino and Signor Orlando for Italy, who were of widely dissimilar historical traditions. But in one respect they resembled him and appealed to his sympathy. They too were party politicians who had led their country through the war. Like him they had failed to grasp the necessity of trusting the work of settlement to more specially qualified men.'

It was Clemenceau, the old journalist-politician and ex-medical doctor, known as the Tiger because of his fierce manner, who disrupted the deliberations. As H. G. Wells said: 'He wanted Germany punished as though she was a uniquely sinful nation and France a sinless martyr land. He wanted Germany so crippled and devastated as never more to be able to stand up to France. He wanted immediate indemnities to recuperate France; loans, gifts, and tributes to France; glory and homage to France. France had suffered, and France had to be rewarded. Belgium, Russia, Serbia, Poland, Armenia, Britain, Germany, and Austria had all suffered too; all mankind has suffered, but what would you? That was not his affair. These were the supers of a drama in which France was for him the star.'

Though Lloyd George brought to the Council of Four a vehement and subtle mind, it was the growing threat of the massed ranks of labour in British industry that was worrying him more than the Terms of Peace. Millions of men had been schooled in the pursuit of war, and it seemed their new outlook was likely to break down old restraints and long-cherished values. It was a threat spreading throughout the world. Because prices everywhere were rising, the wage earner was finding the cost of food, rent and clothing disproportionate to his peace-time pay. Employers in trying to keep down the price of their products and avoid their own bankruptcy were resisting all demands for higher wages. As more and more men left the armed Services, unemployment figures daily rose.



Photographed from an O/400, Handley Page's splendid new factory at Cricklewood had its own aerodrome with take-off runs of about 650 yards. Design and management offices are on the extreme left of the main building. (*Handley Page Ltd.*)

Yet the diminishing number employed in the aircraft industry seemed in better heart than most. Theirs was an enthusiasm which gave cohesion as well as rewards. Thus, though Handley Page was generally regarded as a skinflint, his firm had led the way in establishing a system of profit-sharing with employees. At the staff annual dinner on 22 February the works manager, Mr Hubbard, stressed that if the firm managed to make as much as it was paying out in this manner it would do extremely well. He said that Mr Handley Page, the capitalist of the firm, was the hardest worker in it. The firm was Handley Page Limited, whereas the managing director was Handley Page Unlimited! Hubbard told his employees: 'The past twelve months has been a good year of progress. A year ago we were getting into the new Works, trying to collect materials and to enlarge the staff, and we had the Air Board jumping on us all the time. By the summer we were really turning out machines. Now the works covers 15 acres of land and has an aerodrome of 160 acres adjoining it. The staff and employees have increased fourfold in the past year and the output sixfold.'

Lord Morris of St John's, Newfoundland, who with Lord Belper had recently joined the Handley Page Board, in proposing the toast of the guests, rammed home the point that: 'Loyalty will be still more necessary in the great industrial war of the future. Our nation is handicapped by great debt. In this industrial war we shall have no allies, and we shall have to stand or fall by our own efficiency. We have got to increase output. If all work together we shall pull through – but labour cannot do without capital, and capital cannot do without labour. Only with correspondingly big output to high wages can we maintain the trade supremacy of England.'

A most vital pointer to the future of aviation in Britain was the Air Navigation Bill which was being debated by the House during the second

half of February. As Maj-Gen Seely explained, it was necessary because the Crown law-officers had advised that the Air Ministry had no power to make regulations for civil flying unless through legislation. He said: 'There is no desire to impose upon civil flying any restrictions which would tend to prevent people evolving new types or doing anything they think will advance flying – but it is necessary to have power to secure the safety of the public.' While that was clearly the key-note, Members seemed suspicious that control and inspection were going too far, but Seely made it clear that although there were to be vital inspection processes for all aircraft plying for hire or reward, 'certification would be done daily by persons appointed by the manufacturers with the approval of the Air Ministry'.

Early post-war exuberance with one of the Avro Company's Disposal 504Ks before institution of civil registrations. A number conducted joy-rides for some months in their military guise, khaki painted and with roundels and rudder stripes.

On 21 February the Bill was read for the third time after minor amendment, and now had only to be passed by the Lords and receive Royal Assent. It was generally expected that civilian flying would become legal by 1 April, the beginning of the next financial year. Hopefully, several private groups of pilots followed the lead of A. V. Roe Ltd, and purchased Avro 504Ks with intention of modifying them for joy-riding, in the RFC slang for pleasure flights. Steps were already in hand by Holt Thomas's Airco – which now advertised itself as 'The Largest Aircraft Firm in the World' – and Handley Page for their cross-Channel services, and Robert Blackburn was modifying Kangaroos for a service across the North Sea.

4

The Bill gave a sudden fillip to prospective entrants for the *Daily Mail* Atlantic Flight competition. Already Capt Hugo Sundstedt, a well-known Swedish pilot, had said he would compete with a twin-engined biplane

seaplane, *Sunrise*, and the United States Navy officially stated that arrangements were in hand for some of their pilots to make an early attempt to cross the ocean with a new type of Curtiss flying-boat, though they would not be eligible for the prize. There were reports that a certain Major C. W. F. Morgan 'of the Naval branch of the RAF' was in Newfoundland at St John's investigating conditions presumably on behalf of the British Government – but in fact it was at the initiative of Martinsyde Ltd. Rumour also whispered that Mr C. J. H. Mackenzie Kennedy, whose 142 ft span four-engined Sikorsky-like biplane had been parked at Northolt unflown these many months, was being backed by John Dawson & Co Ltd of Newcastle-on-Tyne with the construction of a somewhat smaller four-engined machine for the ocean crossing. So far there had only been one official entry, and those in the know regarded it as somewhat pretentious.

Several major British aircraft constructors were in the process of building a special machine or modifying a production model, but for the moment they felt secrecy was desirable rather than let rivals know the state of progress. Nevertheless both the Martinsyde and Sopwith companies at Brooklands were well aware of the other's Atlantic intentions and progress, for Fred Raynham and Harry Hawker, the selected pilots, were close friends throughout a sporting rivalry dating from pre-war days. It soon transpired that Morgan was Raynham's navigator but, not unnaturally, Handasyde did not divulge Morgan's report that all the area around St John's was unsuitable for the take-off of a heavily laden machine except for a field he had selected alongside Quidi Vidi lake, half a mile from the town. Hawker's navigator was his trusted friend Commander Mackenzie-Grieve, navigating officer of the seaplane tender HMS *Campania*, aboard which they had often met during trials of Sopwith naval aircraft. Neither company had yet officially entered the contest.

As with all Sopwith designs, it was Hawker who inspired the special features of the Sopwith *Atlantic*, basing the machine on the war-time Sopwith B.1 but with a deeper fuselage to house the big tanks centrally. Because of proved reliability, a 375 hp Rolls-Royce Eagle was to be used. Ingenious Hawker features were the droppable undercarriage, and a small dinghy with watertight compartments carried inverted on the fuselage to form the rear fairing. By the end of February the Sopwith was flying. Before dismantling for freighting it was filmed on duration trials over England by Lieut Engholm of Jury's Imperial Pictures, who cranked his camera from the rear cockpit of a Sopwith Buffalo flying alongside. The Sopwith team reckoned to have the *Atlantic* in Newfoundland by the end of March. Meanwhile they sent Capt Fenn to scout for a take-off place, and after much searching he was lucky to find a possible L-shaped field six miles from St John's, but it was only 400 yards long and edged with fir trees. Hiring a local gang he commenced construction of a hangar and workshop.

Neither Handley Page nor George Handasyde was a newcomer to the

requirements of an Atlantic flight, for both had commenced to build entrants before the war. Abandoning the idea of his pre-war monoplane, Handasyde now entered a slightly smaller biplane than the Sopwith, powered with the relatively light 275 hp Rolls-Royce Falcon. Just as Sigrist and Smith had utilized many Sopwith Cuckoo parts to speed construction of the *Atlantic*, so the Martinsyde team incorporated F.4 fighter parts wherever possible. Construction of the *Raymor*, derived from the names of pilot and navigator, was only a few weeks behind the Sopwith. That both companies proposed using single-engined instead of twin-powered machines provoked criticism among the cautious.

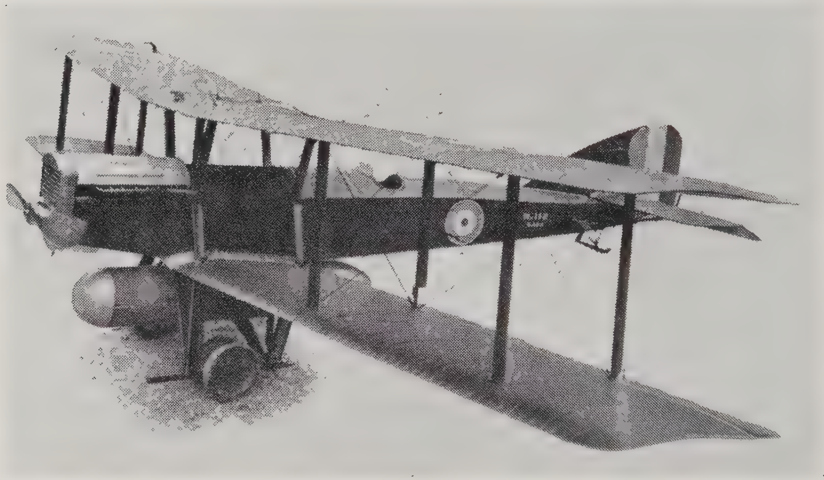
Five days before Hawker had taken the *Atlantic* for its initial test flight, one of the pre-war Brooklands pilots, Capt John Alcock, who had been a prisoner of war in Turkey, visited his old aerodrome, Brooklands, to see if he could get a job, and met Archie Knight and Maxwell Muller whom he had known in pre-war days when he used a Farman there to flight-test a Sunbeam engine, and Knight was a Vickers instructor pilot. At that time 'Jack' Alcock had more flying hours than any other pilot in Britain.

From them he learned that the late Major Bertie Wood had intended to enter a Vimy for the Atlantic contest. In war-time July of the previous year Wood had told the Press: 'The flight can be done the day the authorities wish it. We produce a standard aeroplane that could fly the 1,880 miles in about 20 hours. We asked permission to fly the Atlantic five months ago and were prepared to try it this month had it been granted.' Alcock seized the moment, urging his friends to take him on as a Vickers pilot and let him fly a Vimy from Newfoundland to England in the manner Wood had intended. They had no doubt of his ability. The proposal was put to Acland, who agreed. There was no time to lose. Works orders were issued to adapt the thirteenth machine on the production line. There were urgent conferences between Rex Pierson, Maxwell Muller, and Alcock. On 21 February Pierson was able to notify Acland: 'At present I am getting out drawings of (1) new oil tanks, (2) new water tank of increased capacity, (3) petrol system – and I hope to let Muller have these by tomorrow morning.' Tremendous constructional activity commenced, in which there was no let-up day or night until the machine was ready on the envisaged date six weeks from starting.

Handley Page now entered his four-engined V/1500, convinced that the more publicity he got, the better for his future transport projects. His old friend Admiral Mark Kerr, who had been the first Flag Officer to obtain a pilot's certificate and under whose care had been the Navy's O/400s, was leader of the H.P. flight crew, though the actual pilot was Major H. G. Brackley who had been taught to fly early in the war by Alcock at Eastchurch. As navigator and radio officer a Norwegian pilot, Major Tryggve Gran, was selected: he was the man who found the tent in which Scott and his companions had died on the great Antarctic ice barrier.

Other firms busy with contenders were Short Bros, Boulton and Paul, Fairey Aviation, and Alliance Aeroplane Co. For Shorts this was a unique

occasion because under Horace's autocratic rule they had eschewed all forms of public competition. Oswald saw that with peace-time conditions more opportunity must be taken of creating markets, and as his was a maritime firm it seemed imperative to attempt the Atlantic. In his Shirl N.1B torpedo aircraft there was the genesis of the performance required for this long flight; but as the ply-skinned fuselage was too slender to accommodate the necessary increased fuel a droppable exterior tank would have to be slung from the torpedo housing. It was at this point the



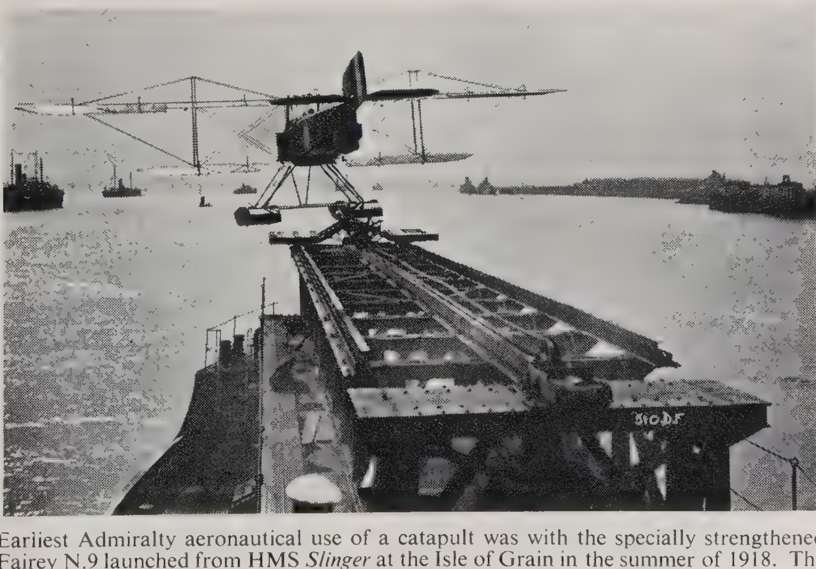
The third Short Shirl, showing final chassis arrangement, was flown experimentally in April 1919 with a large plywood container of $\frac{1}{2}$ ton capacity for mails slung from the torpedo rack, and the machine took off at a maximum weight of 6,762 lb. (*H. O. Short.*)

Air Ministry had abandoned proposals for ordering Shirls both from Shorts and Blackburns, so Oswald endeavoured to secure the third Shirl prototype for the Atlantic flight, with intention of converting it to a two-seater. The Ministry refused, but offered to make an engine available. Oswald therefore laid down a special private venture version of the Shirl, replacing the standard two-bay wings with greater span of three bays, and fitted a vast cylindrical tank of the same diameter as the fuselage. With a total of 435 gallons and a still-air range of 3,200 miles, the machine was now capable of an east to west flight against moderate head winds instead of flying with the prevailing wind as intended by other competitors. Because of the 8,400 lb gross weight and limitation of engine rpm through using a coarse-pitch propeller to give fuel economy, a long take-off run was necessary, and sufficient area could only be found in Ireland, at The Curragh, near Kildare. As tribute to that country the machine was named *Shamrock*. Backed by the sponsor of war-time bounties for Zeppelin destruction, C. C. Wakefield & Co of Castrol oil fame, it was to be flown by Major J. C. P. Wood, with Capt C. C. Wyllie as navigator.

Capt Dawson Paul and the ffiskes at Boulton and Paul agreed to enter a

Capable of 149 mph, the Napier Lion powered Boulton and Paul P.8 mailplane was primarily designed for the transatlantic attempt, but the engines still were not available at the end of 1919. (*Boulton and Paul.*)

modified Bourges, and made overtures to secure the first prototype from the Air Ministry with the intention of substituting twin Napier Lions for the B.R.2s which had been fitted in lieu of the uncertain Dragonfly engines. Delay led John North to evolve a variation which could be used as a mail plane or swift passenger carrier. For the already deep standard fuselage he substituted one filling the entire gap between the wings, and housed pilot and navigator in a cabin enclosure well forward in the nose. He estimated that it would be the fastest twin-engined machine in the world with a probable speed of 150 mph.



Earliest Admiralty aeronautical use of a catapult was with the specially strengthened Fairey N.9 launched from HMS *Slinger* at the Isle of Grain in the summer of 1918. The trolley was accelerated along the 60 ft rail by a high-pressure compressed cylinder, attaining some 40 mph. Note that the flaps were not used. (*H. Busteed.*)

Dick Fairey was negotiating repurchase of his Fairey III two-seat patrol seaplane prototypes, N.9 and N.10 – of which the former had a short-span lower wing and the latter wings of equal span. Sydney Pickles, a free-lance, was entered as pilot, but whether one of these IIIs flew the Atlantic or not, Fairey was certain they were worth buying as demonstrators. He saw sales possibilities all over the world, for the Navy had reported very favourably on the machine after successful air launches had been made by Lieut-Col Harry Busteed with N.9 using an Armstrong catapult on HMS *Slinger*. As a result of these trials Fairey IIIA, B, and C seaplanes became the subjects of initial production contracts, and the first machines had been delivered at the Armistice.

The remaining British entry was the 450 hp Lion-powered P.2 *Seabird* built by the Alliance Aeroplane Company of Acton. Reminiscent of recent de Havilland design, it was a two-bay biplane with ply-covered fuselage in which the two crew members sat low beneath the top longerons where extensive windows were fitted for lateral view, though directly forward the machine was entirely blind. There was doubt whether it could be ready within the next few months.

Neither Geoffrey de Havilland nor Frank Barnwell felt that the Atlantic was a reasonably safe project to attempt at this stage, so there was no entry from Airco or Bristol; but Roy Chadwick discussed with Alliott Roe the possibility of building a special machine, though the idea was abandoned because of expense. However, the majority of firms which had entered considered the cost would be justified by the publicity, and to that end were prepared to write off the price of their aeroplane whether they won or not, and therefore willingly conceded half the potential prize money to their pilot, and a substantial but lesser share for the navigator.

From the USA came a steady stream of publicity that their Navy was likely to be first in crossing the Atlantic with the Curtiss flying-boats but would make an intermediate landing at the Azores. Said Mr Daniels, Secretary of the Navy: 'We are anxious that the US Navy shall get the credit for the first flight. We had hoped nothing should get out about it,

The Felixstowe Fury in final form had a biplane tail and triple rudders similar to the Curtiss T. In expectation of a transatlantic flight the hull, struts, and propellers were painted white. Five low-compression Rolls-Royce Eagle VIII engines replaced the original Eagle VIIs.

but through a slip the fact that Commander Towers has received his orders got known, so I can do nothing more now than confirm the report.' When asked if the Americans really expected to beat the British, he emphatically said: 'We hope to beat the world!' His assertion stirred the Royal Navy's sense of prestige sufficiently to urge the Admiralty to give further consideration to the possibility of beating the Americans with the great five-engined Felixstowe Fury triplane which Colonel Porte and Major Rennie had designed, and which for the first time incorporated control servo motors devised by Major Arthur Cooper. With a span of 123 ft and all-up weight of 33,000 lb it was the greatest flying-boat in the world, as well as exceeding all landplanes except the Tarrant Tabor triplane which was almost ready for flight. But although the Fury had been flying since the previous summer, and its 1,500 gal tankage gave adequate range, it seemed to the Treasury that under pressure of universal cuts and economies the cost of a transatlantic attempt was prohibitive, so the idea was dropped.

5

Secrecies imposed by war to prevent new types of aeroplane becoming general knowledge had left their mark on the aircraft industry. The old carefree atmosphere had gone. Major companies had become industrial empires, and the undertones of business were submerging the vocational enthusiasm of the pioneers into stern competition for survival. Designers kept dark the work they were doing on new types of aeroplane. The men who ran the businesses were surveying future prospects with increasing apprehension. Accountants were trying to put finances in order under necessity of liquidating that heavy duty on excess profits. Even for the bold it was necessary to feel the way cautiously, for profit from the remnant of current production was negligible, and capital must only be expended in guarded measure on new designs.

Robert Blackburn, Claude Grahame-White, Alliott Roe, and the Austin company's John Kenworthy hoped there might at least be a limited market

Perhaps only Blackburns could have designed quite so ugly a little aeroplane as the 40 hp A.B.C. Gnat powered two-seat 'sociable' Sidecar, displayed at Harrods in March 1919 and subsequently at Reading and other towns. (*Flight Photo.*)

for relatively inexpensive low-powered private aerial runabouts. The first result of these several schemes was a two-seat side-by-side monoplane, the Blackburn Sidecar with 40 hp A.B.C. Gnat, enthusiastically devised by Blackburn himself as a logical development of his series of pre-war monoplanes, but designed by A. C. Thornton. He incorporated Blackburn's favourite notion of a triangular-section fuselage structure, placing the wing in mid-position with pilot and passenger in a faired cockpit above the top longeron. It was a hopeful exercise, but with a wing of only 27 ft 3 in, the power and span loadings were too heavy for practicable climb. Nevertheless the Sidecar made so novel a showpiece when displayed at Harrods that it attracted as great a crowd as the completely furnished cabin fuselage of an O/400 which Handley Page with even greater showmanship had put on view at Selfridges. Meanwhile Austins were proceeding with a diminutive 21 ft 6 in span single-seat biplane, the Whippet, which had a steel-tube girder fuselage, conventional wood-structured flying surfaces and rigid steel strut bracing, and was powered with a reconditioned five-cylinder Anzani of only 45 hp. Kenworthy's close acquaintance with the S.E.5 was revealed by its lines. Three years later, as a student, I found this little aeroplane the centre of attraction in the aeronautical laboratory which Handley Page had founded at the Northampton Institute of London University.

Of somewhat similar conception was a 20 ft span biplane, named the Bantam, which M. Boudot had designed in wood for Grahame-White Aviation, and intended to be powered with a 50 hp Gnome, or could take an 80 hp Le Rhône for racing. Even more compact than the Whippet, with pilot and engine closer, the top wing had no central cabane but was bolted to the fuselage at eye level.

At Hamble, Alliott Roe was doodling sketches of an up-to-date version

Three 45 hp Anzani powered Austin Whippets were built. Except for the $21\frac{1}{2}$ ft span wooden wings and the tailplane, the structure was of tubular steel. The prototype, seen here, received its C of A on 4 December, 1919, and, later, was housed at one of the few colleges giving aeronautical training.

Setting a new trend was the B.A.T. F.K.26 prototype, tested at Hendon in April 1919 and seen here at Hounslow. Four passengers could be carried in comfort in the 8 ft long cabin. In 1937 Koolhoven had the remains of this prototype shipped to the Netherlands. (*Flight Photo.*)

of his earlier two-seat triplanes, powered with the 35 hp Green on which he used to rely; but Roy Chadwick persuaded him that a conventional small biplane would be more acceptable using the same engine. Presently drawings of a pretty little biplane began to emerge with longer and more efficient wings than its still unknown rivals, and was hopefully labelled 'The Popular'.

More ambitiously, Koolhoven's big F.K.26 cabin biplane was almost complete. Although structurally orthodox in wood, its appearance gave an impression of considerable potential, but there was criticism of the pilot's location half-way between wings and tailplane because forward view was obstructed by the bulky four-seat cabin. Koolhoven's retort was that he had given the pilot the advantage of surviving in a crash and explaining what had happened!

Throughout this time Geoffrey de Havilland was a sick man, and from his bed at Bletchingley could only dream of such productions, for ever since Armistice night it was Charles Walker who had been in charge of Airco design activities. As a start he had devised a relatively simple conversion of the D.H.4 by replacing the gunner's cockpit with a rudimentary

Several D.H.4s were converted to D.H.4A standard with two-seat cabins. The shipping firm of S. Instone and Co had its D.H.4 G-EAMU converted to D.H.4A. It was normally flown by Capt F. L. Barnard.

Following the lead of the D.H.4A the more powerful D.H.9A was modified in similar fashion as the four-seat D.H.16 for the Airco offshoot Aircraft Transport and Travel Ltd who used several on their London–Paris services.

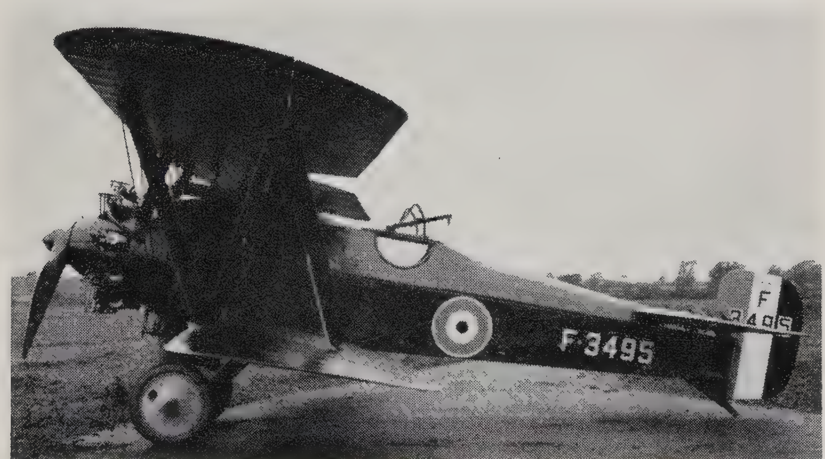
cabin having a hinged lid for access. There was just room to seat two passengers, face to face 'in limousine comfort, entirely enclosed and free from wind or draught'. Several RAF D.H.4s were also modified for their Communication Flight; still bearing roundels and rudder stripes, they were distinguished by aluminium-painted finish which replaced the drab camouflage. Known as the D.H.4A, these variants could make the Hounslow–Le Bourget flight in 2¼ hours. Meanwhile Walker was producing the D.H.16 by the relatively simple expedient of widening the fuselage of a D.H.9A sufficiently to take two pairs of passengers side by side in a cabin just abaft the wings, with the pilot ahead in an open cockpit under the centre-section. Initially powered by an Eagle VIII, it was proposed that a Napier Lion version would follow. The machine's big advantage was lower cost compared with new construction such as the B.A.T., but the advantage could also be played of better visibility for the pilot, though in practice this was negligible.

Walker was equally engaged on development of the D.H.14 Okapi, as well as the D.H.15 Gazelle which was virtually a D.H.9A with Galloway

Before D.H.10 production was in full swing, the Air Ministry contracted Airco to build a long-range bomber competitor to the Boulton and Paul Bourges – it was the D.H.11, shown here, powered with the ill-fated Dragonfly engine. (*Airco*.)

Atlantic engine instead of a Liberty. Concurrently D.H.10s were being modified for the Communication Flight, and at Martlesham the recently completed 60 ft span twin-engined D.H.11 Oxford was undergoing trials – though like the similar specification Avro Manchester and John North's Boulton and Paul P.7 Bourges it had to fly with substitutes for the still unavailable, refractory 320 hp Dragonfly engines. At this point de Havilland was able to return, and proceeded with a far-sighted scheme for a small twin-engined civil airliner, the D.H.17, and then the D.H.18, powered by one Lion engine, in which he located the pilot in the same position Koolhoven had chosen for the identical reason, namely, that the cabin could be disposed around the C.G. so that loading would be less critical in housing the eight passengers. He and Walker were well aware that the economics of this new design were bound to knock the B.A.T. as well as the smaller but somewhat similar machine which Westland was reported to be building.

Like Vickers, the Bristol company was still primarily engaged with military aircraft, although in January Sir Frederick Sykes gave a lead by ordering three Bristol Fighters from the production line to be converted to unarmed communication two-seaters with dual control and increased tankage giving five hours duration. An obvious step was to fit a further Fighter with a cover over the passenger's seat similarly to the D.H.4A.



Despite difficulty with lateral control and poor directional behaviour, the Bristol Badger F.2C was technically a big step forward. Initially flown in February 1919 with a Dragonfly, it was designed for the important new 400 hp Cosmos Jupiter. (*Bristol Aeroplane Co.*)

Frank Barnwell and his directors had experienced bad set-backs with the new single-seat F.1 Scout as well as the two-seat F.2C Badger fighter on which such high hopes had been pinned as successor to the well-loved F.2B Fighter. Both Scout and Badger were tough-looking single-bay biplanes which made their contemporaries appear outdated, yet revealed the

impress of Barnwell's handiwork as first displayed in his pre-war rotary-engined Scout. The new F.1 Scout, powered by the small-diameter Cosmos Mercury in low-drag cowling which almost completely covered the cylinders, had shown brilliant performance from the moment of its first flight at Filton the previous September, except that now the ailerons were impossibly heavy owing to the increased speed. With it the company's new test pilot, Capt Cyril F. Uwins, who had taken up his appointment on 24 October, made his first acquaintance with a Bristol prototype. Despite outstanding performance, the Armistice ended all hope of production of this fighter and its Mercury engine, though since December the machine had been at Farnborough where its spectacular climb was the talk of all pilots.

Slab ply-sided and Germanic in appearance, the Bristol Badger X was tested by Cyril Uwins on 13 May, 1919, but nine days later Barnwell, as an aspiring pilot, nosed it on to its back and it was not rebuilt, largely to keep him from harm. (*Bristol Aeroplane Co.*)

The Badger had proved disappointing. The prototype had been fitted with a Dragonfly as Fedden's new 400 hp Cosmos Jupiter was not yet ready, but on the first take-off, in the hands of Uwins, an air-lock caused the engine to stop, and the machine crashed in his attempt to land just outside the aerodrome. After rebuilding and fitting a larger rudder it was delivered to the Air Board on 15 February, but serious deficiencies of lateral control were revealed which had not been apparent in the tenth-scale model tested in the NPL wind-tunnel. As Barnwell had no tunnel at his disposal at Filton he decided that full-scale investigation was necessary. To that end a simple cheap slab-sided ply-covered fuselage was built for a mere £250 including a disposal 240 hp Siddeley engine, and was fitted with a spare pair of Badger wings. Few believed it had serious purpose, and soon it became regarded as Barnwell's 'Weekender'. Meanwhile the Braemar triplane was engaging most of the Bristol team's attention, for it had proved so promising on early flights that the Air Ministry agreed to provide 400 hp Libertys for the second prototype, known as Braemar Mk II, instead of the low-powered Pumas used for the Mk I in establishing handling suitability. On 18 February Cyril Uwins made the initial flight, and in the ensuing weeks found handling characteristics and performance so satisfactory that Barnwell became absorbed in design of an enlarged 50-

So promising was the first Bristol Braemar that 400 hp Liberty engines were provided for the next instead of 230 hp Pumas. After Capt Cyril Uwins' initial flight on 18 February, 1919, the erection crew had their photo taken with him. (*H. Busteed.*)

passenger version, and a similarly massive flying-boat which had the interest of the Royal Mail Steam Packet Co Ltd as the result of his enthusiastic propaganda.

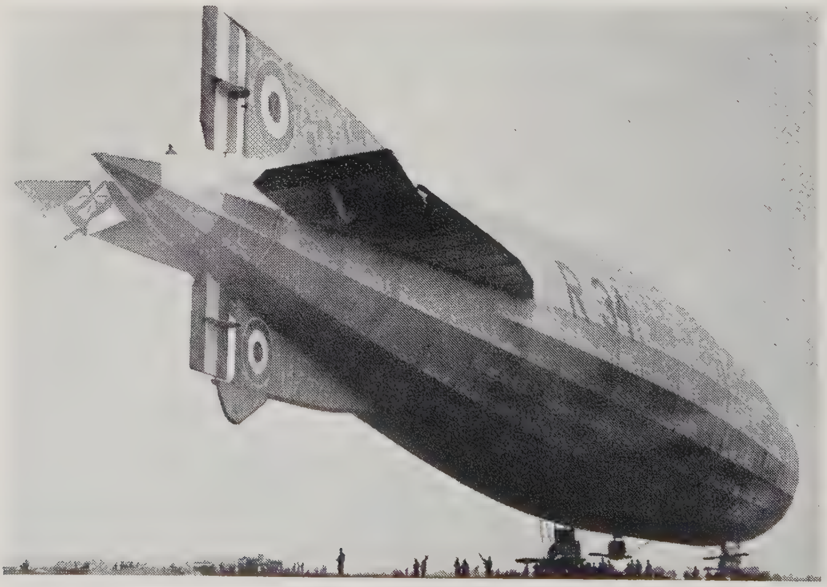
So seriously did the shipping line regard the possibility that they pressed for investigation of steam turbine power. To that end Barnwell discussed with the Air Ministry construction of a triplane having twin 1,500 hp turbines, for which the Braemar I would be used as test-bed. Quotations for the turbine were too high in this period of retrenchment, but the idea which had been mooted of a central engine room sufficiently attracted Ministry technicians to propose a contract for a different triplane powered with four Siddeley Pumas geared to transmission shafts operating wing

Flown in November 1919, the second Bristol Babe was powered with the 35 hp Viale engine originally fitted to the 1912 enclosed Avro Monoplane. Of only 19 ft 8 in span, the Babe was too sensitive for inexperienced pilots and there were no sales. (*Bristol Aeroplane Co.*)

propellers. Barnwell was also promised that the Braemar contract would be amended so that the third prototype could be completed with a new deep cabin fuselage for use as a civil transport for 14 passengers. Concurrently, because he was very much a pilot at heart even though a superlatively bad one, Barnwell was hankering to design an even smaller single-seater than those being tackled by the Grahame-White, Austin, and Avro companies, as he was convinced miniature machines could fly quite well because he had witnessed trials of the 35 hp Kittens at Eastchurch in 1917. He schemed his Babe 15 ft long and less than 20 ft span, employing a V-strutted wing arrangement reminiscent of the French Nieuports, and proposed to power it with a five-cylinder A.B.C. Gadfly radial of 60 hp. But Henry White Smith and Herbert Thomas took the hard-headed view that so cheap a machine could do little to support their big company and temporarily shelved the proposal. Even if aircraft production might prove negligible they were going to keep their great team of skilled wood and metal workers busy with suitable alternatives. Meanwhile there were Bristol Fighters to overhaul.

6

On 6 March there was reminder that Britain's air power did not depend wholly on aeroplanes, for a new Naval rigid airship, the R.33 built by Armstrong Whitworth Ltd, was drawn from its huge shed at Barlow, some five miles from Selby in Yorkshire, and made a trial flight of three hours.



The R.34, flying the White Ensign, was far more beautiful than photographs indicate. Vickers and Shorts were proposing civil airships capable of carrying 50 passengers. (*T. Elsemore.*)

This attractive, well-streamlined vessel, with its diamond arrangement of four Maori-powered gondolas of which the aft one had two engines geared to a single propeller, carried a crew of twenty-three. The cruising radius was said to be 4,800 miles at 60 mph; so here seemed another solution to transatlantic and Empire flying. She was followed eight days later by her sister-ship, the R.34, built by William Beardmore at Inchinnan in Renfrewshire.

Airship construction was a scientific art well known to Oswald Short, for not only had he and Eustace started with balloons and graduated to blimps, but in 1916 they were invited to make two rigid airships, R.31 and R.32 designed by the Royal Corps of Naval Constructors, with wooden structures. A government loan of £110,000 was granted to build and equip a 700 ft double airship shed at Cardington near Bedford, and a village named Shortstown was designated for their airship employees. When the wood-built ships revealed disadvantages, Shorts were asked to complete the R.37 for which duralumin girders had been fabricated by Vickers, and Beardmores built the identical R.36 – both modelled on Zeppelin construction. Before R.37 was completed, the R.38 was ordered *ab initio* from Shorts who established a team of designers under C. P. T. Lipscomb, their former Rochester stressman. Considerable experimental work was conducted on methods of duralumin manipulation, which led Oswald Short early in 1919 to consider designing an aeroplane in that material. Describing his work, years later he told me: 'The light alloy, duralumin, already had a bad name because the first rigid airship used this material but was structurally weak and broke its back when launched at Barrow-in-Furness. Subsequent British-built airships made from duralumin revealed bad examples of corrosion, causing the Director of the Technical Department of the Air Ministry and his chief metallurgical expert to condemn this material for aeroplane construction.

'In 1916 I had made a number of aeroplane ribs in duralumin and tested them to destruction. They proved to be half an ounce lighter than an equivalent wooden rib yet were twice as strong. This was so interesting that I took two unbroken ribs to the Deputy DTD and told him about the tests and their results. To my surprise he did not seem interested, but I continued to take to his office various fittings and turnings made of duralumin as I hoped to convince him that the development was worth while.

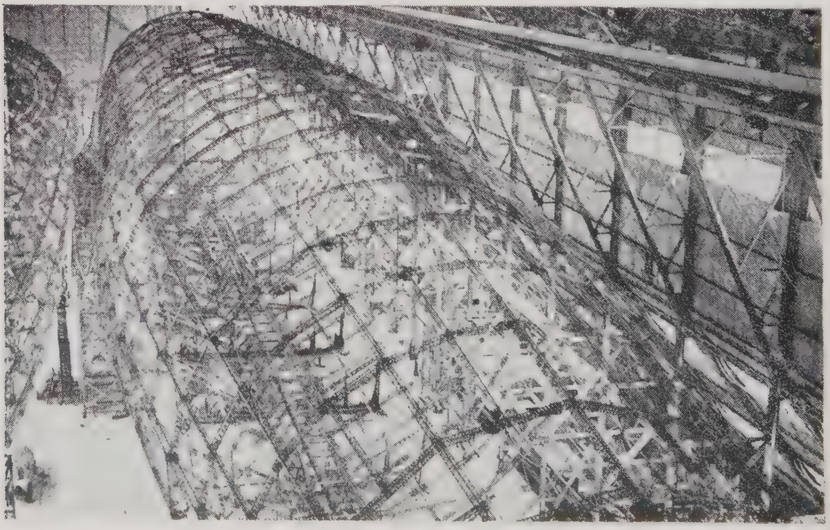
'Early in 1919 I determined to wait no longer for approval from the Technical Department, and started to design what was to be the first stressed skin all-metal aircraft in the world. At the same time I carried out experiments to test possible corrosion of duralumin through electrolytic action when in water contact with ferrous metals. I fixed on our launching pier at Rochester pieces of dural 6-inches square and one-eighth-inch thick and some 10 ft away installed a mild steel plate of the same size and thickness. Both were immersed in the salt water of the Medway each rise of the tide. After about nine months the mild steel plate had rusted

right through, curiously enough at the centre of the plate, but the duralumin plate showed only pin-points of corrosion spattered evenly over its whole surface.

'I showed them to the Air Ministry metallurgical expert in the presence of some of our staff, and demonstrated that the pin-points of corrosion could be rubbed off with a finger, leaving the metal clean. I pushed my finger through the steel plate and broke pieces of rust off. He took the duralumin, and said that if cut through at one of the pin-points it would be found that the corrosion had enlarged as it entered the plate and therefore the effect was more serious than the outer surface of the plate showed. I immediately arranged for a tensile breaking test to be carried out in his presence. A strip 2-inches wide was cut from the corroded duralumin and a similar strip from some unused duralumin. Both broke at almost identical loads, proving his theory incorrect – though I have no doubt that something in his experience had once happened involving duralumin which led to his theory being accepted by others: possibly as the result of impurities in the earliest duralumins.

'When I tried to get a design development contract I continued to be met with scepticism and evasion, so I carried on at my own expense – a private venture.'

What could be offered by way of Air Ministry development contracts depended somewhat less on prejudice than the Air Estimates introduced on 13 March by Maj-Gen Seely as Under-Secretary of State for Air. Few recollected it had been his similar duty five years ago to submit estimates for what had seemed the tremendous sum of £1,000,000 – but



At Cardington in 1919 Shorts were completing the 700 ft duralumin-structured Admiralty R.38, shown with R.37 alongside. C. P. T. Lipscomb was in charge of detailed design. (*Courtesy C. H. Barnes.*)

Shorts' extended seaplane works in 1919 at Rochester on the muddy shore of the Medway. The factory remained unchanged until 1936 and throughout this period full employment was maintained at peak Great War level. (*Courtesy C. H. Barnes.*)

now they totalled £66,500,000, and if the war had continued would have been £200,000,000. For the moment only a token vote of £45,000 was called for. In gilding the pill Seely explained that the full estimate was less than might be thought for although £71,000,000 was voted the previous year it was not an accurate comparison because the Ministry of Munitions had contributed £113,000,000 for the Air Force, and the War Office added £4,000,000, making £188,000,000 in all. 'Thus,' triumphantly said the Minister, 'this year's estimate was reduced by two-thirds,' and of that, £26,500,000 represented surviving liabilities after cancellation of contracts.

After 31 July, RAF personnel would sink to 'peace figures, approximately 5,300 officers and 54,000 men, and the number of squadrons has been fixed approximately at 102.' Seely informed the House that £3,000,000 was being set aside for civil aviation, of which £2,000,000 was for research and experiment, £500,000 for special new types of aircraft, and £500,000 'had been asked for by General Sykes, Chief of Civil Aviation, for the special purposes of his Department.'

The Debate on the Estimates confirmed that few MPs were interested in aviation and the Royal Air Force, though it drew from that battling Parliamentarian, Joynson-Hicks, the comparison: 'Years ago we had command of the sea because we had the coaling stations of the world. To-day we can have command of the air because we have the landing stages of the world.' But it was the matter of Miss Douglas-Pennant's dismissal the previous year from the Women's Royal Air Force which moved the

House far more than the millions of pounds involved in the Air Estimates, and led to such strong feeling against the Government that Mr Churchill had to come into the House to handle the argument.

Certainly a more united front than Parliament was shown by SBAC members at the Savoy on 20 March, where, as one reporter said: 'It hardly seems possible that any other industry could gather at a banquet so many distinguished guests as did the aircraft industry on Thursday night. Its own Secretary of State, its own Under-Secretary of State, Controller-General, and Heads of practically all Departments of its Ministry, and its own MPs were present, each and all on the very best of terms with the formerly despised "Trade".'

As principal speaker Winston Churchill enthralled his audience. 'There is a literary quality in the phrasing of all Mr Churchill's speeches which sets him above those of his contemporaries, and it adds to the statesman-like character of his utterances,' observed C. G. Grey. 'His concluding phrase was worthy of a special notice, for he said: "I express my sincere wish that the British aircraft industry shall consolidate itself and gather together all its strength and press forward on every reasonable and hopeful line of advance until it is quite clear that the conquest of the air in time of peace is as sure and as certain as the conquest of the Hun was bound to be in time of war." '

Of that, the pioneer pilot, Lieut-Col J. T. C. Moore-Brabazon, MP, had no doubt: 'Our aviation is right ahead of any other country in the world. It did not happen by itself. It was because of certain men in this country, and certain men in this very room to-night. It is about time this country said "Thank you" to these men. We have had some of our soldiers decorated and rightly so. The Air Force has received four KCBs, and so has one civil servant – for these men in a very able way knew how to direct the Forces put into their hands – but there were others who supplied the goods, and put them in their hands. The Air Force was given the very best machines in the world, and it is now time that we, the public, should recognize the genius of those who made the machines that gave us the victory. As to the future, do not let us think that it lies in the hands of the Government to make or mar: the future of aeronautics in this country lies in our own hands and no other.'

Maj-Gen Seely turned the tide of approbation to: 'Weir – another man whom I would describe as the founder of victory in the air. Of course, many others have been hard at work, have been doing their best, doing it well, but he just gripped the whole organization, brought all parties together, and made of it a great family. The spontaneous applause with which you received my mention of his name shows that you agree with me that he did wondrous work to give us mastery of the air.'

In reply the remarkably youthful-looking Lord Weir toasted 'The British Aircraft Industry', slyly saying: 'I derive a certain measure of satisfaction from the reflection that, at one time, I was an aircraft constructor myself. I welcome the opportunity of telling constructors what

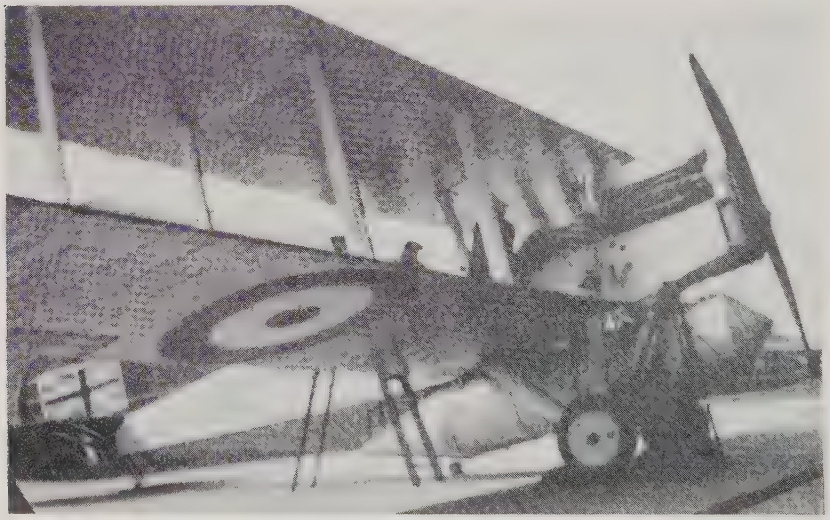
really good fellows they are because in the past I have so frequently had to conceal that friendly eulogy in the necessity of asking for more and more output. I used to tell Mr Holt Thomas what a paragon of production Mr Handley Page was, and Mr Handley Page what a magnificent system was adopted by Mr Holt Thomas.' He could now say that of all great examples of progress during the war he doubted whether any equalled the aircraft industry. In four years it attained a highly technical complexity and expanded from 1,500 people to over 250,000. The great factor had been the existence at the war's beginning of that small band of pioneer firms as a nucleus upon which the whole edifice was founded. They were firms of individuals, animated with a profound faith in the future of flying. They had devoted their time, brains, and enterprise to the thankless task of pioneering a scientific novelty against apathy, scorn, and in many cases, often ridicule. They had faced the certainty of very large outlay and a problematical return. Starkly Lord Weir warned: 'When you think of the great industry as it stood on Armistice day, when you consider the immediate future of military, civil and sporting aviation, you fully appreciate that you have to trim your sails to meet those altered conditions. Quite definitely many of you who came into war-time aircraft production, many of you who made it an auxiliary to your other industry, should clear out of aviation and leave the more limited field to those who genuinely have a prior claim.'

In support, the SBAC chairman, Mr H. White Smith, warned: 'We have now to consider how we can reorganize our industry from a war industry to a peace basis. But I think it is well to sound a note of warning, because a great many people, in their enthusiasm for aviation, are taking it as though commercial aviation was an achieved success. It is for us, as businessmen, to differentiate between what we imagine and what we believe possible in the light of what has already been achieved.'

In fact the financial outlook appeared depressing, for the new year had brought an epidemic of strikes, though industrial wages seemed enormous compared with pre-war standards. War had taught labour the art of extorting wage advances by intimidating employer and Government alike. They were out for more. Shipwrights and engineers led the way; gas and electric workers threatened to plunge London into darkness; coalminers renewed their attack. The Government retaliated with the threat of DORA which empowered them to imprison strikers. But the coalminers were determined, and on the issue of dangerous working conditions demanded nationalization of mines, 30 per cent more wages and a six-hour day, with full wages from State Funds as a subsidy to every demobilized miner until reabsorbed. The Government was forced to act. An immediate advance of 1s a day was offered and Mr Justice Sankey appointed as head of a Royal Commission which must report by 20 March. With considerable dissension the miners agreed to postpone strike notices until two days after that date. It drew the promised report on time. Sankey proposed a wage increase of 2s a day and work hours reduced to seven until July 1921,

when a six-hour day would follow. A levy of 1d a ton would be imposed on mine-owners for a fund to improve the squalid condition of housing. Despite minor bickering by mine-owners the Government accepted the terms, adding provisions for miners to have a voice in management. But outcry for nationalization could not be stilled. It had an unsettling effect on every other industry, though the aircraft manufacturers seemed less affected than other trades.

For the moment several transatlantic flight attempts were diverting attention from contemporary civil flying developments. Once the Sopwith had been shipped there was no further reason for secrecy, so details were released and the firm's entry was officially notified to the *Daily Mail* on 19 March. Those of the Short *Shamrock*, Martinsyde *Raymor*, and the Fairey III seaplane quickly followed. Hawker and his navigator arrived in Newfoundland with the crated machine on Saturday, 29 March, but St John's harbour was blocked with ice and the ship had to be diverted further west for unloading. Teams of horses pulled the crates to the snow-covered little field Capt Fenn had selected, and uncrating and erection immediately commenced.



Shamrock, a variant of the Short Shirl, was built for the transatlantic prize and had an external fuel tank similar to the Shirl's mail receptacle. An additional bay added to the Shirl-type wings gave a span of 62 ft 2 in. Total fuel capacity was 435 gal and range 3,200 miles. (*Short Bros.*)

At home, trials of the Martinsyde concluded with a simulated flight of 24 hr duration with the *Raymor* lashed down and Raynham and Morgan sitting it out in full flying kit and the engine running at continuous cruising rpm until fuel was exhausted. The Falcon was then stripped, examined, re-assembled, and the machine freighted to Newfoundland.

Concurrently the Vimy was nearing completion; yet it was only a few


On Good Friday 18 April, 1919, the clear-doped transatlantic Vickers Vimy was ready for test in the hands of Jack Alcock, who found it perfect. Extra tanks increased fuel capacity to 865 gal and gave 2,440 miles range.

days before the Sopwith crew arrived in Newfoundland that the Vickers' team found a navigator. Until then Alcock had said he would make the flight solo. Suddenly the right man turned up – Lieut Whitten Brown, a semi-crippled ex-RFC observer who for months, like thousands of other officers, had been visiting aircraft and engineering factories with less and less hope of a job. He had been given an introduction to Maxwell Muller and was interviewed at Brooklands. Brown mentioned that beside being a trained engineer he was a navigator. More by way of conversation than in earnest Muller asked if he could navigate an aeroplane across the Atlantic. Brown leapt at the idea. With eager enthusiasm he talked of navigating aircraft over long distances; clearly he knew his subject. Muller took him to the erecting shop where the almost completed Vimy was standing, and introduced him to Jack Alcock. With the dual bond of flying and having been prisoners of war, Alcock was certain within a few minutes that in Brown he had found the man of value who could accompany him.

Unwillingly the Air Ministry was bestirring itself. A grandiloquent statement was issued to the Press: 'Within the next few weeks, perhaps within the next two days, an effort will be made to cross the Atlantic by an aircraft. The accomplishment will mark a new and historic advance in the development of aviation. The Air Ministry, recognizing the difficulties and the importance of securing successful flights by British machines, have placed their information, knowledge, and resources at the disposal of the aircraft firms and pilots who have decided to attempt the flight. Arrangements for carrying out the flight are necessarily prolonged and arduous. Some firms desiring to compete were without machines because their

whole output was under contract to the Government, so the Air Ministry has released machines where necessary. Others were without necessary engines, instruments, wireless telegraph apparatus etc., and the same facilities have been afforded to secure these. Owing to meteorological considerations it has been generally decided to start from the American side of the Atlantic, and the Ministry had endeavoured to secure shipping priority both for machines and pilots to facilitate a start at the earliest possible moment. The moon will be full on April 15, and it is probable that the first attempt will be made by Mr H. G. Hawker, flying the Sopwith, on or about this date. It is expected to start about 2 a.m. Newfoundland time (10 p.m. British time). He would thus fly through the night, and if his venture succeeds should arrive between 4 and 5 o'clock in the following afternoon.'

The Air Ministry statement outlined navigational procedure, the necessity of ships co-operating with wireless and visual contacts, and the nature of distress signals. Meteorological information would be issued in conjunction with the US Weather Bureau and the Canadian Meteorological Office in Newfoundland; the Marconi Company would co-operate by collecting and transmitting all relevant information free of charge from land stations and ships. An Admiralty notice, issued to all Atlantic shipping companies, was even more explicit in requiring vessels to look out for aircraft and render all help possible.

On 18 April, 1919, *Shamrock* took off from Eastchurch, where it had been tested, for Ireland at a gross weight of 8,400 lb, piloted by Maj J. C. P. Wood. Lankester Parker flew the prototype Shirl in formation with Shamrock. (*Imperial War Museum.*)

Further news of entrants quickly followed. Handley Page confirmed his entrant would make the attempt, and Boulton and Paul officially entered their twin-engined 'Commercial Model with two Napier Lion engines'. Things were moving fast. On Friday, 11 April, it was reported that Hawker had tested the Sopwith *Atlantic*, but was weatherbound by rain and thick mist. His nearest rival, the Martinsyde and crew, had just arrived. Four days later the Handley Page V/1500 was shipped to Newfoundland. Next day the Martinsyde was ready, and at lunch-time was tested in a lull between storms. Hawker and Raynham were on level terms. Another two days and the Vimy was wheeled out at Brooklands

for Alcock to make his first test flight. That same Good Friday the *Shamrock*, piloted by Wood, flew from Eastchurch to Holyhead where it refuelled, and then started to cross the Irish Channel for its final take-off point. Twelve miles out from Anglesey the engine stopped. There was no alternative but to alight on the choppy sea, and the wings were wrecked though the plywood body floated. Said Wood: 'I am still a competitor and hope to be ready to start early in May.'

7

Though ex-RAF officers hopeful of flying jobs were discovering their chances negligible, many key figures who had helped ensure success of war-time airframe and engine production were channelling their abilities into new specializations. Capt W. O. Bentley had quietly escaped from the scene apparently unnoticed by the authorities, and was designing an impressive sporting car while his legal advisers prepared an award claim on his rotaries for the Inventions Commission. His equivalent in the fixed engine field, Major F. B. Halford, whose latest design was the twelve-cylinder BHP Pacific of 550 hp, had joined the staff of Engine Patents Ltd, of Pall Mall, London – a new company under the technical direction of Harry R. Ricardo, that great expert on induction systems and valve gear, whose engines had been fitted exclusively and by the thousand to British Tanks. Their intent was to design power units of all kinds, whether for car, lorry, generating plants, or aircraft, or undertake technical investigation of any design problem. Meanwhile Ricardo's recent collaborator on fuel detonation, Colonel Henry Tizard of Martlesham fame, had accepted a Fellowship at Cambridge.

Similarly Lieut-Col Alec Ogilvie, that important official whom Oswald Short believed was at loggerheads with his firm, had relinquished his appointment with the Air Ministry Technical Department. Taking with him the key men – Lieut-Col W. A. Bristow; Major R. H. Mayo; A. J. Sutton Pippard; F. P. Walsh; and H. C. Watts, the leading authority on propellers – he associated them as Ogilvie & Partners Ltd, consulting aeronautical engineers, to form a team of exceptional standing and ability.

Then there was Capt Albert Peter Thurston, DSC – one-time assistant of Hiram Maxim and now an authority on widely ranging systems of metal construction – who found his civilian niche as consultant and patent agent. Draughting patents was specialized work, and he could count on many contacts in the war-time aircraft industry to ensure successful business. Indeed it was a fascinating vocation, for study of specifications issuing from the world's Patent offices could reveal every imminent development, so that from the sequence of patents granted to any aircraft firm the type of aeroplane they were designing could be deduced. Nevertheless he might have been misled by Alliott Roe who on behalf of his firm had been patenting almost every detail of his cherished 504, for refinement and weight control had made this machine the quintessence of light-weight design.

First British civil aircraft registered was this D.H.6, with non-standard rudder, raced by Airco pilot Gerald Gathergood at Hendon in the summer of 1919. A number of D.H.6s were bought for joy-riding, including one with a Curtiss engine. (*Flight Photo.*)

For the crowd of pilots hopefully eyeing the dawning prospect of civil aviation the Avro 504K was the one aeroplane which might give them a start, for it could easily carry two or three in a modified rear cockpit and still retain the ability to operate from very small fields. Yet the special dispensation permitting flying to commence within Great Britain at Easter found the first registration, K-100, allocated not to an Avro but a khaki D.H.6 'Clutching Hand' owned by Airco and still wearing Service roundels and stripes on the rudder.

That chilly Victory Easter, as the daily Press euphemistically termed it, gave opportunity for many to indulge in the new thrill of aerial joy-rides at two guineas a head. At Cricklewood Handley Page had disposed an O/400, and soon 600 people had taken a ride. At Hamble A. V. Roe Ltd

Early post-war joy-riding businesses chiefly used war-time Avro 504Ks adapted with tandem seats in the rear cockpit. The machine illustrated was employed at Blackpool by the Avro Transport Company. (*J. C. C. Taylor.*)

Harry Hawker flying the B.R.2 powered prototype Sopwith Gnu, which was the second British civil registered aeroplane. Like the slightly smaller cabin Avro 546, two passengers were carried side by side in the enclosed rear cockpit, but the Gnu had no immediate market. (*Flight Photo.*)

arranged a big programme, with admission at 2s 6d and flights at only £1 for a circuit, and Lieut-Col G. L. P. Henderson and Capt Hamersley gave aerobatic exhibitions and joy-rides. The company also had little fleets of 504Ks at several other places and, including groups of joy-riding businesses operated by ex-RAF pilots, there was passenger-carrying from beaches at Southport, Blackpool, Weston-super-Mare, and from fields at Scarborough, Harrogate, Manchester, and others dispersed throughout the country. All were using machines obtained from the Disposal Board at about a quarter the price for which they were built.

Brooklands marked the occasion with the first flight of the second British aeroplane to be registered, K-101, a Sopwith Gnu three-seater in

This Avro 526, at Southsea, was a four-passenger modification of the 504K which offered prospect of profit in joy-riding, but the aft C.G. rendered it too unstable to be a practicable seller. (*C. A. Nepean Bishop.*)

that company's tradition with rotary engine and two-bay conventionally strutted wings like the Avro 504K, though derived from the Buffalo. Two passengers sat side by side in the rear cockpit under a hinged glazed roof of D.H.4A pattern. It was one of several small-class civil aircraft which Tom Sopwith was going to offer for private ownership.

At Hendon, that Mecca of pre-war flying, Claude Grahame-White had a few 504Ks so busily engaged on joy-riding that he saw he could do even better with bigger machines so, despite his feud with the Air Ministry, tendered for three disposal Kangaroos from which he would strip the military gear and build-in two large cockpits each accommodating three passengers, and another could be carried in the nose cockpit. Meanwhile he was hurrying completion of the little Bantam, for there were rumours that A. V. Roe, still confident that flight was possible on low power, had authorized construction of Chadwick's single-seat biplane.

People had taken with a will to this excitement of joy-riding but whether it was a true augury for civil transport was questionable. Everywhere a spending spree gripped the populace as an antidote to the restrictions and long drabness of war, the water-logged trenches, the years of camps and billets and munition factories. There were gratuities to spend, and a restlessness for entertainment, an urge to see the English countryside by train, car, or motor-cycle, and even bicycle. No wonder that aeroplanes drew crowds, for they were thrilling novelties to the oncoming generation, and for many of their elders these pilots had something of the air ace glamour which war-time propaganda had ensured.

A new outlook was permeating all classes of society, marked by lessening cohesion in family life. The post-war young woman, flaunting short skirts and bobbed hair, with freedom to pick her own job, typified the independence heralding this post-war age. It seemed good to be flippant and amused and casual. Yet for the young men who had matured in the Services, but had been too young to have pre-war jobs, it was another matter: once their gratuities had gone they were discovering the difficulty of finding employment.

Nor were things any too well at the Peace Conference. Clemenceau was playing up President Wilson and his 'Fourteen Points' – so much so that the American addressed the delegates saying: 'Gentlemen, I am in trouble, and I have sent for you to help me out. I do not know whether I shall see M. Clemenceau again. I do not know whether he will return to the meeting this afternoon. In fact I do not know whether the Peace Conference will continue. M. Clemenceau called me *pro-German* and abruptly left the room.' Said Clemenceau when he heard of it: 'How can I talk to a man who thinks himself the first in 2,000 years to know anything about peace on earth?'

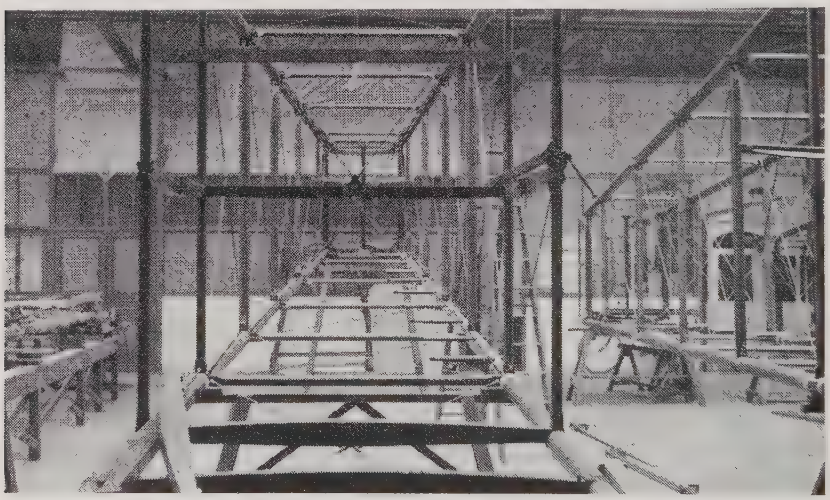
Concurrently the *Daily Mail* was savagely attacking Lloyd George and his 'hang the Kaiser' state of mind. Backed by the Press campaign, 370 Conservative MPs in April sent the Prime Minister a telegram expressing grave anxiety at lack of progress at the Conference. Lloyd George

vehemently defended himself in the House, and returned to Paris cock-a-hoop at the thunderous applause the Commons had given him. On 7 May, agreement was at last reached by the Conference, and the completed Treaty was presented to the German Delegation, who were under guard at the Trianon Hotel in Paris. How drastic were the conditions could be judged from Article 231: 'The Allied and associated Governments affirm and Germany accepts the responsibility of Germany and her Allies for causing all the loss and damage to which the Allied and associated Governments and their Nationals have been subjected as a consequence of the war imposed upon them by the aggression of Germany and her Allies.' A week later, the President of the German Delegation, Count Brockdorff-Rantzau, formally rejected the Treaty.

Three days before this happened Rex Pierson and Maxwell Muller were on the quayside at Southampton to wish the best of luck to the Vickers transatlantic crew boarding the *Mauretania* bound for Halifax. Alcock and Brown's arrival at St John's on the 13th caused surprised dismay to Hawker and Raynham when they appeared next morning in the breakfast room of the Cochrane Hotel, despite mutually vociferous greetings. However, Alcock's ebullience was somewhat flattened on discovering the necessity of searching for a big enough take-off area for their heavily laden machine. There was nowhere within 30 miles of St John's; it seemed the Sopwith and Martinsyde teams had been fortunate even to find cramped locations at Glendenning's Farm and Quidi Vidi. Of the Handley Page crew all that could be discovered was that Capt G. I. Taylor, ex-RAF meteorological expert, had been appointed navigational adviser to Admiral Mark Kerr who had established headquarters 60 miles from St John's at a place called Harbour Grace. To all, it was disturbing to learn from an American journalist that the three Curtiss flying-boats of the US Navy were ready to leave at a moment's notice; but weather was impossible, with sleet, rain and low cloud as it had been for weeks.

If little was known of progress in assembling the complex V/1500, Mr Handley Page was certainly stirring interest in Great Britain for he had issued a prospectus inviting the public, as one paper slyly said, 'to risk £500,000 offered at par in the shape of cumulative and participating preference shares in return for a fixed minimum dividend of 7 per cent and the chance of a maximum dividend of 14 per cent if earned. Considering the reputation in practical aeronautics of Mr Handley Page, it is to be hoped that this venture into the arena of public finance will add to the success of the Handley Page concern and the wealth of the investors concerned. The public are paying for the name and expect good stuff and profitable results: the original capital was £10,000, but one must take into consideration the epoch-making events, the extraordinary developments and complete change of character since the "civilizing" influences of the war first manifested themselves. As the purely financial aspect of the transaction, Mr Handley Page receives 140,000 of the 150,000 ordinary £1 shares for the patents, designs, inventions, etc., and also for any improvements on

further inventions relating to aircraft made by him during the seven years ending 31 December, 1925. By this agreement he undertakes to act as managing director for seven years from 1 January, 1919, which agreement he can extend for successive periods of three years throughout his life. Of the £500,000 raised by the present issue of preference shares £100,000 will be used for paying off loans to the bank, raised for the purpose of coping with the growth of the business, and the balance will provide working capital and also meet the purchase of the factories and plant erected by the Ministry of Munitions.'



Handley Page V 1500 fuselages under construction at Cricklewood, showing the McGruer hollow longerons and the wire-suspended interbeams for the cat-walk (right) to the rear gunner's position. The structure was remarkably slender for so big a machine. (*S. T. A. Richards.*)

The critics were suspicious. Frederick Handley Page was confident. He had been to the Air Ministry. He had argued the case for a development contract for a new twin-engined aeroplane which would be equally suitable as a civil airliner or a troop-carrier. The Minister was interested. There were difficulties of course. Handley Page said that obviously it was his last wish that his company should be specially favoured, although they certainly knew more about big aeroplanes than anyone else, but perhaps a specification could be evolved for competitive tender by other companies as well? A competition, mused the Minister. Perhaps something might be done. He would give it further thought.

Handley Page, physically a big man, balding, his personality strongly developed, was even now only 34 years old, but his name had become a household synonym for giant aircraft. Francis Kappey, the RFC reservist who had accompanied Capt Busby on the first flight of the V/1500, had returned from the war and obtained a job in the H.P. drawing office, and recollecting those days he told me: 'I found that my immediate boss,

Volkert, was a man of quiet disposition, whose competence was overshadowed by the autocrat whose name the company bore. Nobody argued with H.P. He was a bad payer – for staff could be bought very cheaply in those post-war days. At the same time he was capable of acts of great kindness.' That was the general opinion. Those in closest contact with Handley Page knew him as a great intellect, whether in technics or business or the humanities and arts, and were prepared to overlook his meaner foibles for the inspiration of working under such a leader. Everywhere it was he who made the decisions. No aspect escaped his imagination: thus in the whirl of activities he was pondering whether a wing could give more lift than the wind-tunnel recorded for conventional forms. He thought of parachutes and the stabilizing effect caused by the jet of air passing through the hole at the top. Did it, he wondered, add to the lift? He had been very interested watching Miss Sylvia Boyden recently jumping with a Calthrop parachute from one of his machines at Cricklewood. Would holes through wings steady the flow of air?

8

That sunny May had at last opened the skies internationally to civilian pilots, for in the London *Gazette* of Wednesday 30 April there had been printed the text of the new Air Navigation Regulation:

> In pursuance of the powers conferred upon me by the Air Navigation Acts, 1911 to 1919, and all other powers enabling me in that behalf, I, the Right Honorable Winston Spenser Churchill, one of His Majesty's principal Secretaries of State, by Order make the following Regulations:
>
> No aircraft shall fly within the limits of the British Islands and the Territorial Waters adjacent thereto unless the following conditions are complied with:
>
> (i) the aircraft shall be registered in the prescribed manner;
>
> (ii) the aircraft shall bear the prescribed registration and nationality marks, affixed or painted on the aircraft in the prescribed manner;
>
> (iii) the personnel of the aircraft should be licensed in the prescribed manner;
>
> (iv) there shall be carried in the aircraft
>
> (*a*) the certificate of registration,
>
> (*b*) the licence of any member of the personnel who is required to be licensed;
>
> (v) the provision of these regulations as to general safety, and the rules as to lights and signals and rules of the air, as set out in these regulations, shall be duly complied with.

The regulations detailed the general safety provisions, registration, licensing of personnel, certificates of airworthiness, log book requirements, prohibited areas, and established rules for aircraft arriving in or departing from the United Kingdom, together with lights, signals and rules of the air.

It was a document which manufacturers as well as every potential aircraft operator were earnestly studying – particularly the precedent of

certificates of airworthiness. There was some concern that because it had become mandatory to send the Director of Research general arrangement drawings of any proposed new aircraft this meant giving away to government officials all the tricks of the trade, with some risk that they might be divulged to competitors. But the requirement was irrefutable. In future every design must first be approved by the Secretary of State so that Ministry experts could be satisfied as to safety; subsequently construction must be approved for workmanship and material. Thereafter these same 'experts' must be satisfied that flight trials demonstrated the aircraft to be safe for its intended purpose. Manufacturers could not but question whether arbitrarily appointed officials, who probably had no creative design experience, could keep abreast with developments sufficiently to be unbiased arbiters of progress.

Peter Legh (left) and Frederick Koolhoven standing by their demonstration B.A.T. Bantam Mk I, F1655, at Hendon, with a D.H.10 in the background. Seven of these little aeroplanes were civil registered and one was taken by Koolhoven to Holland in 1924. (*G. Quick.*)

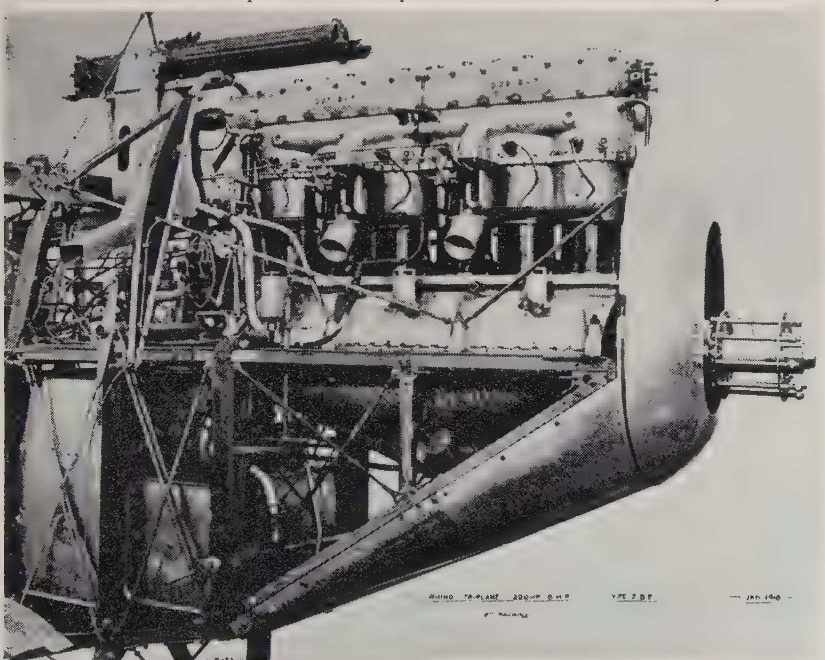
That even the most advanced designers could overlook small but vital design safety requirements was tragically illustrated by the fatal accident to Flt-Cdr Peter Legh on the first Saturday in May when he fatally crashed after his 320 hp A.B.C. powered B.A.T. Basilisk caught fire during an attempt on the world height record from the London aerodrome at Hendon.

Perhaps he might have brought his aeroplane safely down had the simple expedient been adopted of fitting a metal-asbestos sandwich fire wall behind the engine to insulate any flames from the pilot. Although rotary-engined aircraft had a transverse aluminium shield across the fore end of the fuselage it was more to prevent oil streaming through the fuselage; many stationary-engined aircraft had nothing, or were only partially bulk-headed; so now this disaster to the fierce and advanced-looking Basilisk became one of the factors leading to a mandatory fully sealed fire wall for every type of military and civil aircraft.

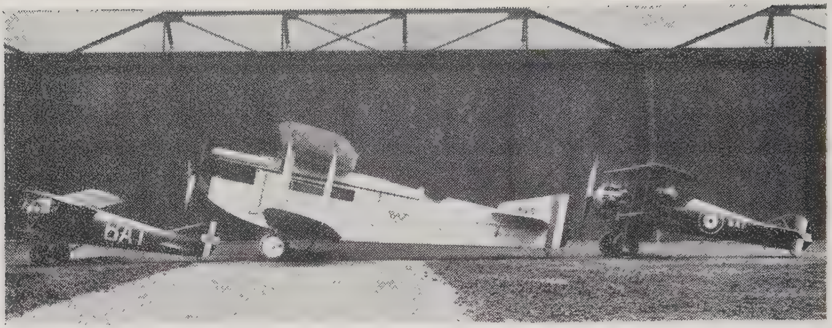
Because big power was the vogue, and the earlier Bantam lightweight fighter could not be stretched, Koolhoven and Noorduyn had designed the dimensionally similar but more powerful Basilisk, in which the poor

chord/gap ratio of the Bantam was eliminated by placing the wing well above the fuselage instead of on it. The 320 hp Dragonfly, when it worked, not only ensured brilliant performance but its greater weight enabled the pilot to be located behind the centre-section trailing edge where he had a much better view than from the Bantam's mid-chord cockpit which had access through a hole in the centre-section. Speed was reputed to be 160 mph, with startling climb, easily exceeding the potential of the new Sopwith Snapper, a single-bay biplane with something of the appearance of an S.E.5, the similar Siddeley-Deasy Siskin, and the Murphy-designed Armstrong Whitworth Ara.

Said C. G. Grey: 'Peter Legh and Frederick Koolhoven made a wonderful combination, for the pilot's absolute reliability and judgment as a tester were a perfect guide for the designing and constructing genius of the engineer. So complete was the understanding between them that the result was as if one man had been doing both the testing and designing. They were, as it seemed, critic and author in one. Peter was typical of those young aristocrats who may yet by that same simplicity and ability of mind make this nation again what it used to be before stress of war and the machinations of politicians set almost everybody in their wrong place.' With that valediction passed the impress of the first British test pilot to be



The 230hp BHP in the Sopwith Rhino typified standard engine installation of the day, with no fireproof bulkhead, and oil and petrol tanks packed close to the engine. If petrol vapour was present a carburettor back-fire could ignite it. The middle wing-spar is visible below the gun mounting. (*Fleet Air Arm Museum.*)



High hope was pinned by Koolhoven on the possibility of post-war sales of the three machines lined up in this photograph: the F.K.23 Bantam, the F.K.26 small civil transport and the F.K.25 Basilisk. (*G. Quick.*)

killed in post-war years. His place was taken by his close friend – tall, wavy-haired and handsome Major Christopher Draper, who had served with him in the RNVR.

A less dangerous crash, witnessed with dismay by Alliott Roe, Chadwick, and Broadsmith, occurred on the first attempt at flying the prototype Avro Popular on 30 April. Capt Hamersley had taken off from their little aerodrome on the foreshore at Hamble, and at 300 ft accidentally knocked off the ignition switches, lost speed, flicked into a spin, and crashed on to the soft muddy fringe of the estuary. The pilot experienced little more than shocked dismay, but the pretty little aeroplane was too damaged for reconstruction. As pre-flight publicity had been sent to the Press, including pictures of the structure before covering, a second machine was urgently put in hand, keeping the crash dark lest it affected future sales, and the new airframe was henceforth regarded as the first prototype. By the end of May its construction was well advanced among a batch of six others.

In war-time khaki with RAF rudder marking, the neat Avro Baby prototype was an attempt at a practical aeroplane using minimum power. The 35 hp Green engine originally fitted to the 1911 Avro D was used after modification to bring it up to date.

Remote in Newfoundland throughout early May the possibility of prompt take-off by the three American flying-boats was irking the British pilots, but weather remained impossible, with pouring rain and unchanging predictions of storms over the Atlantic. In England a far smaller flight than this unreality of flying the great Atlantic Ocean had held the headlines. On the very day that civil flying commenced, Herbert Thomas of Bristols by strangely fortunate coincidence had arranged 'an important appointment in London with Maj-Gen Seely, and decided to take immediate advantage of the removal of restrictions on civil aviation. From the various types suitable for commercial flying he chose a Bristol Coupé as the most convenient for his purpose. In spite of blowing almost a gale, rain falling in heavy showers, and mist and low-lying clouds making conditions most unfavourable, Mr Thomas started on his journey piloted by Capt Uwins. An excellent landing was made at Hounslow 58 minutes and 5 seconds from time of taking off. Mr Thomas thus won for himself the distinction of being the first civilian passenger to land at an officially appointed aerodrome in the British Isles.'

Like Airco with their civil modification of the D.H.4, the Bristol Coupé, with Puma engine, was a conversion of a famous Bristol Fighter with wider fuselage and enclosed two-seat cabin and primarily built for American sales in the absence of British interest.

Handley Page also ensured his share of publicity by sending an O/400 piloted by Lieut-Col W. Sholto Douglas with 10 'passengers' and 6 cwt of luggage, from Cricklewood to Manchester where they arrived after a 4-hour flight.

The *Daily Express* and the *Daily Mail* were less fortunate with hired aeroplanes which failed to reach their destinations, one of them, a D.H.9 piloted by Capt Saint, crashing in the mist on Portsdown Hill. Later in the day a film company was luckier, and successfully sent some reels from Reading to Manchester in a Bristol Fighter piloted by Capt West, and the *Daily Mail* used a Nieuport Nighthawk for newspaper delivery. On 3 May a Fairey seaplane, which had been transported by barge to Blackfriars, was flown by Sydney Pickles from the Thames opposite the Houses of Parliament to Westgate and Margate with copies of the *Evening News*.

That paper also hired a Handley Page O/400 with which Major E. L. Foot flew from Hounslow to Brighton, Eastbourne, and Hastings, to drop copies by Guardian Angel parachute at each town. Not to be outdone the *Daily Mail* two days later sent an O/400 from Manchester where it loaded newspapers and 10 passengers for a circuit of Scottish towns to Montrose and back, and while passing Aberdeen Major Orde Lees descended by parachute 'to pay a visit to an old friend'.

Journalists and photographers were quick to use aeroplane taxi services for which Airco arranged several D.H.9s as three-seaters. Here one is piloted by Lieut Jerry Shaw for Aerofilms who made considerable business by photographing country houses. (*Aerofilms.*)

There was general feeling that civil flying had made a good start in England; nobody wished to admit this might be because of the novelty. In the House the Under-Secretary of State for Air was asked whether permission would be granted to private owners to fly aircraft only if they had insured against third party risks 'so that innocent sufferers may be certain of recovering loss for proved damage to the commission of which they have not contributed?' He was assured by Maj-Gen Seely that every possible safeguard had been provided in the new regulations.

There was no feeling of assurance for the British transatlantic competitors. On the 8th the three American flying-boats had left Long Island Sound on their initial 1,000-mile leg northward to Trepassey Harbour from which their carefully planned attack on the sea route to Europe would be made. Ominously two of the four Liberty engines of the NC-4, which Lieut-Cdr Read was piloting, failed *en route*, and the machine came down in the ocean 100 miles off-shore from the Massachusetts coast but despite rough seas taxied through the night to Cape Cod harbour. How-

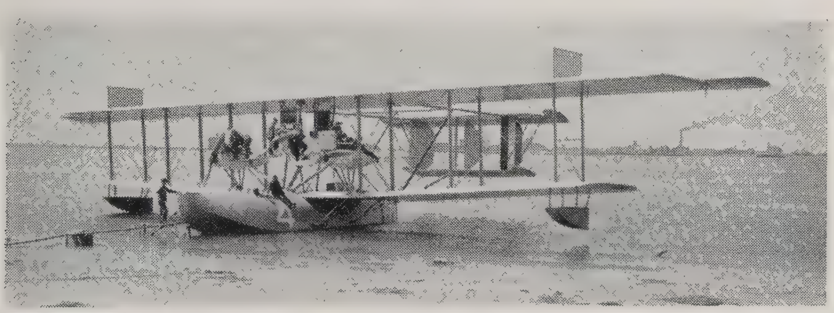
ever both the NC-3 piloted by Commander J. H. Towers, and Lieut-Cdr Bellinger's NC-1 reached Halifax harbour where a depot ship awaited.

They arrived at Trepassey Harbour on 12 May. *The Times* of that day contained an announcement opening even greater vistas than the brief paragraph describing the adventures of the Americans:

FLIGHT FROM ENGLAND TO AUSTRALIA
ANOTHER £10,000 PRIZE

'The preliminary conditions of the Australian Government's offer of a £10,000 prize for the first Australian airman to fly from Great Britain to the Commonwealth have been arranged at a conference attended by representatives of Mr Andrew Fisher, High Commissioner for Australia in London, the Royal Aero Club, and the Air Ministry. The prize, which must be won before December 31st 1920, is open only to Australians using seaplanes, flying-boats, or aeroplanes of all-British make. The distance, varying from 15,000 to 17,000 miles according to the route, must be completed in 720 hours. A disabled machine may be towed a total distance of 100 miles, but no further than 20 miles at any one time.'

On 16 May, three evenings after Alcock's arrival at St John's, the three big American flying-boats took off for the Azores. Preparations had been meticulous compared with the almost casual arrangements of the British crews. The entire route was patrolled by 27 destroyers strategically placed along its length, with a depot ship half way.



The Curtiss NC-4 represented a derivative of the pre-war Sopwith Bat-boat. The short hull with booms to carry the tail was assumed to create less water resistance than a long hull. After successfully completing the stages of its Atlantic flight, the NC-4 finally reached Plymouth but was freighted home. (*Smithsonian Institution.*)

The NC-4 maintained continuous radio contact with the patrol vessels and flew without incident for 15 hr 13 min, alighting at Horta, on Fayal Island in the Azores, at 1.25 p.m. Greenwich time, having flown 1,400 miles at 3,000 ft except for a last difficult leg in fog at 200 ft. The NC-1 was less successful. After flying into dense fog it had to alight on the open sea 100 miles from Horta; later in the day it was found by the steamship *Iona*, but was badly damaged in an attempt at towing. The NC-3 had even worse fortune, for it flew off course in the rising fog, and was missing for four

days until finally located seven miles from Ponta Delgada on 19 May bravely taxi-ing in damaged condition, its crew exhausted, and a man on the starboard wing-tip balancing the machine on an even keel because the port wing-tip float had been knocked off.

To Hawker and Raynham, with their machines at the ready, it came as a great shock to learn that the Americans had started. They had been waiting a month. Meteorological reports for their own flight were hopeless until early on Sunday morning, 18 May, when Lieut Clements, the weather expert sent by the Air Ministry, gave news that the storms were abating. It was just past the full moon. Here was their chance. The next few hours confirmed that conditions were improving. Under a sporting agreement not to steal a march on each other, Hawker confirmed to Raynham that he intended to take-off during the afternoon, and cheerfully added that he would meet him for dinner in London the following evening.

Harry Hawker's Sopwith transatlantic contender, powered by a 375 hp Rolls-Royce Eagle VIII, had a span of 46½ ft and length of 32 ft. At an all-up weight of 6,150 lb the disposable load was 3,000 lb including 400 gal of fuel. The small inverted dinghy can be seen on the fuselage. (*Fleet Air Arm Museum.*)

Briefly the British Press recorded: 'On May 18th, inspired by a determination not to be defeated by the American pilots, Mr Hawker accompanied by Lieut-Cdr Grieve left Newfoundland at 5.40 p.m. Greenwich time. On his way he dropped the wheels of his chassis on the Quidi Vidi aerodrome where Mr Raynham was getting ready to start. He then passed out to sea, flying steadily in a favourable wind. Nothing more has since been heard.'

An eye-witness at St John's described the impact of that occasion: 'It is a great pity you have not been with the Sopwith and Martinsyde expeditions, for you would have seen flying in one of nature's most sanguinary settings, and no pen can describe the sight of Hawker and Grieve slipping away over the signal tower of the harbour mouth in a sporting effort to beat the Yanks to it. I think the stoutness of the attempt is just beginning to sink into our consciousness now.

'The flying fields were enough to give anyone the creeps when it was remembered that the machines would have to stagger off with a heavier load than anything of their weight has had to carry since the world began. Half a day's rain made Hawker's place a swamp, and he only had a fair

run when the wind was north-east or south-west. A forced landing anywhere for miles meant a certain crash. Fog and rain shut everyone in for the best part of a month. Then, when the Atlantic weather cleared, the local fogs descended, or the winds blew from a quarter giving no room to taxi. Fair winds here were only echoes of storms in the Atlantic.

'Raynham and Morgan had to take the chance of crashing or staying behind on Sunday. Their field was a narrow strip of hard ground near a large pond. Between them and the sea, in the line of their natural take-off, is a line of cliffs about 300 ft high, with intervening streams, scrub trees and rocks. It was a case of run down wind for it or stay home. The Martinsyde waited a whole hour, hoping for a shift, which sometimes happens in local winds very quickly in the late afternoon. Her engine was singing prettily, and there was no fault in his technique when Raynham taxied off. The weight was telling very severely, and I do not think his plane attained speed before it crashed, although another 20 yards might have done the trick. Passing over some bumps, the pretty little scarlet and yellow machine hopped twice a few feet in the air. Then the undercarriage folded up, and that was the end of their attempt. The tanks burst, and the ground, machine, crew, and half of St John's were soaked with petrol. Raynham got hit by the joystick and his eye was cut. Morgan's gammy leg got jammed, and his other one was bruised; his left eye was cut, and he had a long gash on his left cheek. Both were groggy for a minute or two and could make no effort to get out. Then someone pulled Morgan out, and Raynham managed to make it on his own. He stuck to his job of getting the bus back into the hangar, then washed his face and came home to supper. I have never seen a chap take disappointment in a more sporting way. The doctor has put his foot down on Morgan for any more flying, and is sending him home by the *Corsican.* Raynham says he will rebuild and try again with another navigator. I wish him luck, but he has a hard job ahead.'

End of a dream – the Martinsyde transatlantic entrant crashes during take-off in Newfoundland.

Graham Wallace in *The Flight of Alcock and Brown* tells that Raynham had little to say, but what he did say was forceful. Alcock and Brown on returning to the Cochrane Hotel after searching all day for a take-off field, found him remarkably cheerful despite bandages and plaster, busily planning repair of the *Raymor* for another attempt. Sportingly he offered free use of his field for assembly of the Vimy, though it would be too small for ultimate take-off with full load. Not until 26 May did the Vickers machine arrive on a day of driving rain and bitterly cold wind. Alcock cabled Maxwell Muller: '*Glendevon* arrived safely rumour Hawker Grieve rescued obtain and cable log and experiences. Transmisson weather reports to here, bad. Use influence to expedite consult Sopwith Handley Page. Alcock.'

Hawker and Mackenzie-Grieve had earlier been reported to have alighted at sea 40 miles west of the Shannon – but it was false. Anxious days followed. Hope dwindled and vanished. Stormy weather throughout the week eliminated all chance of escape for the Sopwith crew in their tiny dinghy. No more was known than that a red light had been seen in the air at 4 a.m. on 19 May by the SS *Samnanger* about 1,000 miles from Newfoundland on a direct course to Galway. By the end of the week all except Muriel Hawker believed them drowned. The *Daily Mail* gave assurance that it would provide for her and her baby daughter. From Buckingham Palace came a telegram: 'The King, fearing the worst must now be realised regarding the fate of your husband, wishes to express his deep sympathy and that of the Queen in your sudden and tragic sorrow. His Majesty feels that the nation has lost one of the most able and daring pilots to sacrifice his life for the fame and honour of British flying.'

Those in high places were already washing their hands of responsibility. The Under-Secretary of State for Air made clear in the House that the Air Ministry's attitude was to enjoin caution upon competitors rather than urge them to make the attempt. Though backing entrants with facilities for weather reports, radio, and other matters it was solely to make the venture less hazardous. With fine magnanimity the Officer Commanding, RAF Dublin, was instructed to place himself under orders of the Admiral at Queenstown to assist with aeroplanes in a search for the missing Sopwith, but gales and low clouds prevented even a take-off. However, the Navy ordered immediate despatch of a number of destroyers, but a communiqué warned: 'As regards future flights the Government feels bound to call attention to the many and heavy obligations of the British Fleet. These involve duties in many parts of the world which cannot be set aside. The Admiralty have special commitments in the Mediterranean, the Black Sea, North Russia, the Red Sea, and the Baltic – in which, indeed, there has been fighting within the last few days. They are also responsible for the vast and continuous mine-sweeping operations. Things being so, whilst the Government is, and has been, most anxious to do everything it can to save such gallant and intrepid airmen as Mr Hawker and Commander Grieve, it feels bound to warn those who may in future make the attempt to fly the Atlantic that its resources make it impossible to undertake the

immense task of patrolling 2,000 miles of the ocean by way of protection.'

But Mrs Hawker had divined correctly. On 25 May a small Danish steamer, the *Mary*, hove-to on calm seas off the Butt of Lewis and signalled with flags to Lloyd's station on the cliffs:

'Saved hands – sop – aer – opl – ane.'

Eagerly Lloyd's look-out semaphored: 'Is it haw – ker?'

Back came the answer: 'Yes.'

It was a story which thrilled the world. England was as jubilant as though the conquest of the Atlantic had been achieved. Even the heroisms of the war seemed eclipsed. Nothing was quite so dramatic in all history as this surprising rescue of two men deemed lost in the wild waste of the ocean on this first great challenging attempt to fly the Atlantic direct.

The *Mary* was intercepted by HMS *Wolstron*, and Hawker and Grieve taken to Scapa to spend the night aboard HMS *Revenge*. Next evening they arrived at King's Cross where a crowd of 100,000 packed the station and forecourt to welcome them 'with greater enthusiasm than is shown for a great commander or a statesman of world-wide renown'. Half a regiment of Australians were so vociferous for their fellow-countryman that the Royal Aero Club reception committee could barely make itself heard. When the car carrying Hawker and Mackenzie-Grieve to the Royal Aero Club in Clifford Street broke down, the jubilant Australians first towed and then carried it like a triumphal throne through the packed crowds. This proved too slow for the police, who mounted Hawker on one of their horses to finish the journey in style.

Earlier the *Daily Mail* had announced that it would divide £5,000 between pilot and navigator in recognition of their determination in making so risky an attempt under such bad weather conditions. In the issue of that paper on 27 May Hawker told the story of his flight: 'The sky was quite clear for the first four hours, when the visibility became very bad. Dense cloud banks were encountered, and eventually we flew into a heavy storm with rain squalls. Trouble did not begin until we were five and a half hours from St John's. It was about 11 p.m. Greenwich time, and the clouds were still exceptionally thick. We were at about 10,000 feet, and many cloud peaks reached 15,000, making a very bad horizon. The moon had not yet risen, and having to go round the clouds made it difficult to steer a good course. It was freezing hard.

'But now the radiator water temperature rose from 168 degrees to 176 degrees Fahrenheit in a few minutes, staying like that a couple of hours or more. I decided to throttle the motor and put the nose down steeply in hope that this would clear any refuse in the filter. It proved successful; so I decided to go beneath the cloud. Down at 6,000 feet we found it blacker than ever and had to drop to 1,000 feet above the water before we could see to fly.

'With the sun just rising we started on course again but could not keep the temperature below boiling, so decided to fly diagonally south-east and then south-west across our course to see if a ship could be found as it

seemed inevitable the engine must seize. After two and a half hours we spotted a vessel close to our port bow. Flying alongside her at 400 feet we fired three Very distress signals, and spent some time flying across and across until men came on deck. Then we went ahead about two miles and alighted in front of her. We made a very good landing, and although a high sea was running the machine floated on even keel well out of the water. Waves up to twelve feet high were breaking over the machine but our life-saving suits kept us dry, and for an hour and a half we watched the crew of the *Mary* trying to launch a lifeboat. She was only 200 yards away. After much difficulty they succeeded in getting to us, and we boarded the boat and were pulled to the ship by a line. Owing to the heavy sea it was impossible to salve anything at all.'

Unadorned, those simple words enabled millions to sense the tremendous drama of this great and lonely endeavour at reaching into the unknown not merely to win a prize, but to blaze a great air route for the better communication of the two richest nations in the world.

Harry Hawker and Mackenzie-Grieve were commanded to Buckingham Palace to be congratulated by the King who awarded them the Air Force Cross. At a luncheon held at the Savoy, Lord Northcliffe presented them with the cheque for £5,000. Nor did the crew of the *Mary* go unacknowledged. The miracle that she was there at the right moment was very much in mind. Her crew received a silver medal for gallantry in saving life at sea, and the Board of Trade presented pieces of plate to Capt Duhn and the coxswain of her boat, as well as money to the crew.

Now came news that Lieut-Cdr Read piloting the NC-4, the only one of the three remaining serviceable, had left the Azores on the 27th for the 900-mile flight to Lisbon. This was successfully achieved the same day, and then by easy stages the big flying-boat proceeded to Plymouth Sound where she arrived through the afternoon summer haze of 31 May, alighting within sight of the steps from which the *Mayflower* had set sail almost 300 years earlier. There was no official welcome, nor even a car to take the crew to their hotel.

Capt W. H. Sayers, that war-time RNAS technical officer at the Isle of Grain, where he suffered persistent attacks of malaria, had joined the staff of *The Aeroplane* and wrote: 'The wave of popular enthusiasm which has swept this country over Mr Hawker's attempt to fly the Atlantic has obviously little to do with the actual nature of the achievement. As a sporting event, Mr Hawker's effort was undoubtedly a fine thing. There was no risk that the Americans would wrest the *Daily Mail* prize from him, and his action in starting under relatively unfavourable conditions can only have been dictated by the desire for a Britisher to be the first to cross. That is why the British public has let itself go over Hawker.'

In a letter to *The Times*, Lieut-Col H. T. A. Bosanquet stressed the real crux: 'The affair has merely been regarded as a sporting event somewhat similar to, but on a larger scale than the first cross-Channel flights. The two are not comparable. The accomplishment of the transatlantic venture

calls for the highest technical skill and practical experience on the part of the navigator. Whereas it might be possible to pick out at least 1,000 pilots from the RAF qualified in skill, physical endurance, and courage to undertake this flight, it is probable that really competent navigators, possessing the technical navigating knowledge, combined with the equally necessary practical experience of long oversea flights, could be reckoned on the fingers of one hand.

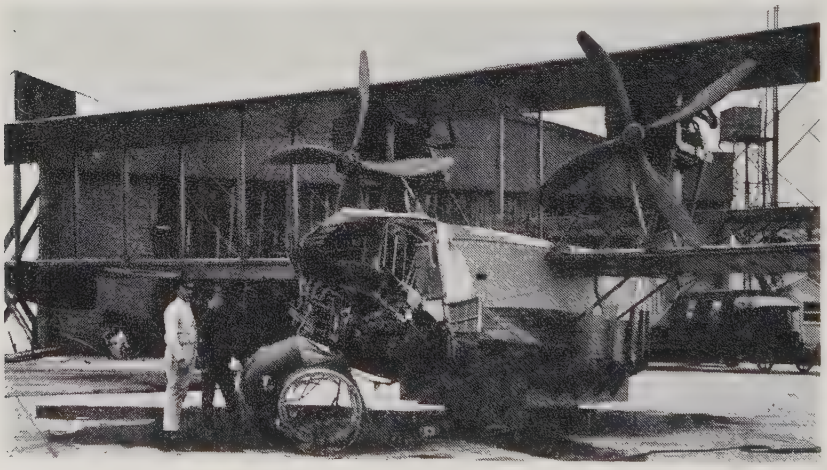
'In oversea navigation, whether flying high or low, the most extraordinary errors can be made. A good example is furnished by the NC-4 which ran into fog and had to depend on DR calculations for some 170 miles. When her position was again established by one of the route-marking vessels she was 45 miles out in her reckoning. In the Sopwith flight, Mackenzie-Grieve found himself by astronomical observation about 115 miles off his DR course in a run of 900 miles. When such large errors are possible it is easy to see that dependence on dead reckoning is out of the question. Directional wireless is still in its infancy. It has given most promising results, and undoubtedly will be the method of air navigation in the future, but it is not yet sufficiently developed to be reliable. Astronomical observation can be carried out from an aircraft, but with much greater difficulty and less accuracy because cloud horizon must be used or an instrument having its own artificial horizon. Hence it becomes necessary to fall back on DR as the main principle, but Naval expert opinion at the Air Ministry considers a transatlantic flight dependent on this method alone would be highly hazardous.' Even the most optimistic of potential airline operators, and certainly the far-seeing Handley Page and Holt Thomas, realized that this deficiency would hold back civil passenger-carrying across the Atlantic for many years.

10

While the people of Great Britain were readapting themselves to the rigours as well as the pleasures of peace, people in Germany were dying of undernourishment. The Army of Occupation was trying to succour a starving population, and the C-in-C was urging the Peace Conference to supply food and medical supplies. But to the British, the German nation was still the beast of the Apocalypse; the propaganda atrocity stories of the war had sunk in. Said Clemenceau to the Americans: 'We have had to bear the insolence of the Germans for 50 years. It is new to you, and therefore it makes you angry.' But no German, and particularly their new youth, could understand why they were thus vilified. The nation bitterly resented the Peace terms, but though Count Brockdorff-Rantzau made counter-proposals, President Wilson refused to alter a word. Germany was instructed to sign by 7 p.m. on 23 June.

In Russia things were even more confused. A Marxist doctrinaire named Lenin headed the quarter-million Bolsheviks autonomously in control. Class hatred and murder were rampant. In January four Grand Dukes had been executed in defiance of Lenin's reprieve. Industrialists,

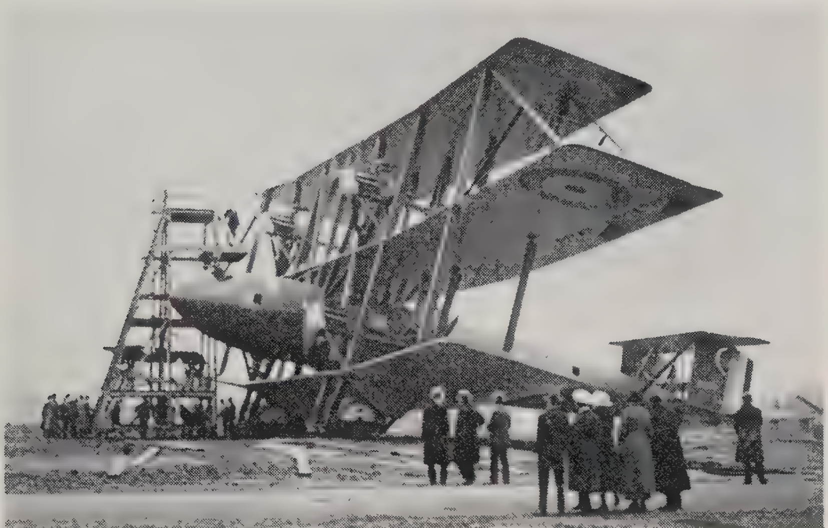
managers, technical experts were denounced. Only the workers counted, and theirs was a mass hysteria which provided few results. Everything was becoming shabby and threadbare. Shops remained closed, and only a black market supplied food, for the peasants on the land were producing barely enough for their own subsistence. Yet only last August, British and French Forces had been landed at Archangel to maintain the country's stability, nor had they been withdrawn. Several RAF squadrons were with the British Expedition, equipped with D.H.9As, Snipes, R.E.8s, and a few 'Little Acks'. Serving with them were such famous pilots as Capt J. Ira 'Taffy' Jones, late of No. 74, and Lieut-Col R. Collishaw, the great Canadian ace, commanded No. 47. With them was the greatest Russian fighter of the war, Staff Capt A. A. Kazakov who was gazetted Major on 1 August, 1918, and placed in command of the first Slavo-British Squadron. Among his friends was Lieut-Cdr A. P. de Seversky who had been sent by Kerensky to the USA as vice-chairman of the Russian Naval Air Mission but transferred to the American Air Service when the Bolsheviks seized power; another was young Ivan Smirnoff who had managed to reach England after being shot down in November 1917, and became a CFS senior instructor until the end of the war. Others left Russia after the Revolution and like their great aircraft designer, Igor Sikorsky, sought sanctuary in the freedom of America.



The last of Commander Porte's Felixstowe designs was the F.5, N90, but the prototype met disaster at Calshot. Subsequent F.5s were virtually F.3s brought up to date. Only a few were completed and eventually used as the standard RAF flying-boat after the Armistice. (*T. Elsemore*.)

Meanwhile the triumphant stage-by-stage crossing of the Atlantic by the US Navy's flying-boats tempted the Air Ministry into belated propaganda tacitly comparing it with a 14½-hr duration flight made by a Porte F.5 flying-boat from Felixstowe around the south-east coast to Brighton and reciprocally to Lowestoft and back to Felixstowe. 'No attempt to

land was made until the engines actually stopped from lack of petrol,' ran the communiqué. 'An important point to remember is that no special modifications were made, and the ordinary Service load was carried. The total weight was 13,710 lb of which 150 lb was water shipped in the choppy sea before taking off. The average speed was about 55 knots, and wireless communication was maintained with the base at Felixstowe throughout the flight.' It was hardly spectacular though determinedly British. More impressive was an experimental commercial flight of a Handley Page V/1500 which travelled 520 miles in six hours, piloted by Clifford Prodger who was still doing much of the H.P. testing at this time.



Starting the engines of the 37 ft high Tarrant Tabor triplane was a long business, requiring a special gantry as engines had to be turned by hand. A disadvantage of multi-engines was that an hour might elapse between starting the first and last. (*Courtesy The Royal Aeronautical Society.*)

However, it was to the vast potential rival of the Handley Page that official eyes had been turned, the Tarrant Tabor – only to witness disaster on the very day Hawker and Mackenzie-Grieve were so triumphantly welcomed in London. There had been a steady publicity build-up. Nearly two months earlier, the assembled Press of Great Britain was collectively introduced to the skyscraper-like triplane which had been under construction more than a year with initial intention that it would be used for bombing Berlin. Although design stemmed from W. H. Barling, assisted by Capt T. M. Wilson who had stressed the V/1500, the RAE regarded it almost as their own, and Mr Sidney Smith, the new Superintendent, had placed every facility at the disposal of the Tarrant company.

While Tarrant's system of built-up Warren girders allowed considerable constructional standardization, it had taken longer than expected to build

First trial of the Tabor ended in disaster, the nose crushing in as the machine turned further over while the top wing structure collapsed. However, two of the crew escaped from the undamaged rear portion of the fuselage. (*Courtesy The Royal Aeronautical Society.*)

the massive prototype, and it proved heavier than estimated. Few aircraft have ever been lighter than expected.

Sceptics criticized the fuselage suspension between middle and bottom wings, for it depended on two pairs of broadly sloping centre-section struts which made a V in elevation and passed through the fuselage to form an apex at the centre of the lower wing. It was frail judging by Handley Page experience. The great cigar-like fuselage itself, skinned in two-ply varying from 5 to 3 mm and covered with fabric, varnished and enamelled, was certainly a beautifully streamlined job. An entire absence of transverse bracing wires, made possible by the fabricated arches, showed what extensive space could be offered to passengers in a similar civil airliner. Although the span of the middle wing was 131 ft 3 in, which was only 5 ft more than the V/1500, the area was 4,950 sq ft compared with 3,000 sq ft of the Handley Page; height was 37 ft 3 in. So big was the assembled machine that it had to be drawn sideways from the great balloon shed using bogies under the wheels and tail. Compared with the almost ideal Avro 504K, the Tarrant's all-up weight was twenty-five times heavier but the disposable load was thirty-four times greater because of the lower safety factors which could be employed with a big machine in which the rate of manoeuvring would be small.

Capt F. G. Dunn, AFC, one of the regular pre-war pilots at Hendon, was designated for the first flight because of his experience with the V/1500,

together with Capt P. T. Rawlings, DSC, an experienced engineer who had flown O/400s and was recently appointed manager of the Tarrant Aeroplane Department. They were accompanied by Capt Wilson, as technical observer, and three RAE foremen as crew.

Though the test was at light loading, 1,000 lb of lead had been secured in the nose to overcome alleged tail heaviness. Some time was spent in getting all six hand-cranked engines started, and the machine was then taxied with six crew aboard to Cody's favourite area between Jersey Brow and Laffan's Plain where a number of turns were made and eventually a 'straight' with tail lifted off the ground. The pilot appeared to be opening up the two upper engines when without warning the machine nosed over. As it slid with earth flying, the front portion of the fuselage collapsed and the triplane reared over the vertical on to the leading edges of its wings. When the ambulance rushed up the two pilots and Capt Wilson were found so injured that they died in hospital. All too late it was realized not only that the undercarriage was too far back in relation to the C.G., but the centre-section undoubtedly had insufficient rigidity and failed in the struggle to hold the two undercarriages in line as they bumped over the rough Farnborough ground.

Though this was a tragedy inseparable from the development of aviation, there was welcome return to the informally competitive spirit of earlier days when the first post-war aviation meeting was held at Hendon on 31 May and 1 June. Officially it was to celebrate the return of Harry Hawker, who arrived in the Sopwith Gnu with Mrs Hawker as his passenger, but it would have been staged in any case as a fairground for sporting flying. There was tremendous demand for flights with Hawker; tickets were sold by auction and the first knocked down at 60 guineas, the next two fetching 40 guineas, and the rest from 10 to 20 guineas. Of the

Grahame-White bought Blackburn Kangaroos for joy-riding, with cockpits arranged for seven passengers. In drab khaki green, the third machine is shown taxying out with a mere 3½ lb of mail for a flight between Hounslow and Newcastle during the 1919 railway strike. (*Courtesy B. A. Hewitt.*)

Kangaroos which Grahame-White was using for joy-riding, a humorist remarked: 'They looked like badly nourished Handley Pages.'

Pundits were particularly fascinated in watching initial test flying of the little Grahame-White single-seat Bantam, its fuselage painted blue with wings a brilliant yellow. In the hands of Mr Chamberlayne it appeared to have deficiencies of control and stability. Said Capt Sayers of *The Aeroplane*: 'He is a dashing pilot, but either the side surfaces of the machine need redesigning, or he has a curious way of handling it, for it has an ugly habit of progressing cornerwise for an appreciable time before getting into a bank when starting a turn.' Almost as interesting were the series of familiarization and test flights by Chris Draper on the 375 hp commercial B.A.T. F.K.26. The pilot, who had considerable experience of all Koolhoven's war-time designs, was very pleased, and endorsed the comments of his friend the late Peter Legh that the machine was absolutely perfect on controls, and the only alteration necessary was to improve cooling with larger side radiators. Next day Draper flew to Joyce Green accompanied by Commander Towers of the NC-3 and Lieut-Cdr Bellinger of the NC-1, and lunched at the RAF Mess. It was the familiar comradeship of one pilot to another, whatever their nationality or creed.

To improve view, the top wing of Grahame-White's second prottoype Bantam was slightly raised, but like the Bristol Babe, handling was not easy and a fortnight after the 1919 Aerial Derby it crashed into a hangar at Hendon and was written off.

But what impressed expert and amateur alike at Hendon was the uninhibited acrobatic display of a Boulton and Paul P.7 Bourges IA powered by Dragonfly engines, which arrived from Norwich piloted by tall, bespectacled Frank Courtney, their one-time draughtsman. Taking off in what seemed a mere 30-yard run, he climbed phenomenally, and then thrilled the crowd with loops and rolls and spins as though it was a fighter scout. Shortly after he landed, a strange twin-engined biplane with deep rounded fuselage and blunt hemispherical nose came humming in, and was recognized as the Vickers Vimy in new commercial form with portholed cabin seating 10 passengers in what seemed remarkable comfort and ample headroom.

In the hands of Capt F. T. Courtney, the prototype Boulton and Paul Bourges IA, at last with twin Dragonfly engines, put up a breathtaking show of looping, rolling and spinning, although machines of this size had hitherto been regarded as non-aerobatic. (*Imperial War Museum.*)

Rex Pierson had made a splendid conversion, constructing the cabin with rings of box section set on four spruce longerons spaced at the same depth as the standard bomber Vimy, and covered with stitched Consuta. 'This material,' stated the Vickers brochure, 'is claimed to be much stronger than ordinary plywood, and is made by S. E. Saunders Ltd of Cowes, which firm is now allied with the Vickers Company.' The rest of the fuselage was standard Vimy suitably deepened with formers and stringers and covered with fabric to follow the shape of the cabin. Like most aircraft at the meeting it still wore RAF rudder colours and wing roundels, but its civil status was emphasized by the symbol K-107 painted in white on the grey fuselage. First flight had been at Joyce Green on 13 April, and since then Capt Stanley Cockerell had been putting it through trials prior to an intensive sales campaign. There was talk of entering one for the great race to Australia.

Supermarine at Woolston had similarly investigated the possibilities of civil flying and repurchased a number of their A.D. two-seat patrol flying-boats, including nine still undelivered. Several were converted to carry two passengers in tandem in the main cockpit and a third in the bow with

K-107, the Vickers Vimy Commercial prototype seen outside Grahame-White's Country Club at Hendon in July 1919. Subsequently this aircraft was registered G-EAAV for an attempted flight to the Cape by Capts S. Cockerell and F. C. G. Broome.

Repurchased by Supermarine, several A.D. flying-boats were designated Channel class, and began pleasure flights along the South coast on 23 July, 1919. N1529 is shown leaving Southampton during that August.

the pilot behind him. A 160 hp Beardmore was fitted for economy. 'It is the intention to concentrate on short flights with passengers,' ran the company's publicity patter. 'The latter will embark from various pier-heads on a circular route which the flying-boats will cover, including Ryde, Ventnor, Sandown, and Shanklin, which later will be extended to Bournemouth and Weymouth, and eventually to Le Havre and St Malo.' Behind these plans was the energetic mind of Supermarine's managing director, Commander J. Bird, who was determined to earmark all port-to-port commercial flying as theirs, and to emphasize it renamed the A.D. boats the Channel class.

The day after the Hendon air meeting the first of a series of auction sales of disposal aeroplanes and equipment was held by No. 1 Aircraft Salvage Depot at the adjacent Hyde. Six Avros, two Armstrong Whitworth F.K.8s, two B.E.2es, and six D.H.6s were on offer 'ready to drive away'. With gentle irony a reporter commented: 'Judging from the prices one could see that the Disposal Board would not lose much by giving the stuff away.' The biggest bid was £360 for a 110 hp Le Rhône Avro; the two Ack Ws went for £260 each; the two B.E.2es at £90 and £80, and the six D.H.6s anything from £100 to a mere £60 for a single-seater version with Curtiss OX-5 engine. If aeroplanes could be bought so cheaply it augured badly for the plans of Tom Sopwith and others to build sporting aeroplanes.

11

By yet another coincidence the wreckage of the Sopwith *Atlantic* had been discovered by the American freighter SS *Lake Charlotteville* still afloat 10 days after Hawker had been picked up. It was salvaged and brought to

London docks. The canny Gordon Selfridge got hold of the relic and throughout the week following 2 June displayed it on the roof of his store in Oxford Street for all to see without charge.

Meanwhile in Newfoundland the Vickers team at Quidi Vidi had almost finished their arduous open-air task of assembling the Vimy. Nearby the *Raymor* was still being repaired in its hangar. Weather had improved by Newfoundland standards, but Alcock could not find a field suitable for full-load take-off, so cabled that it was urgent Maxwell Muller should visit Harbour Grace to persuade Admiral Mark Kerr and his Handley Page team to let the Vimy use their large air-strip. It was needless. Before Muller could arrive, the haulage contractor who transported the Vimy crates to Raynham's air-strip learned of the difficulty and told Alcock that he owned a long grazing meadow which might be suitable. It seemed another doubtful chance, but Alcock immediately went to inspect, only to find it dotted with granite boulders and limbered with young spruce trees and had a drainage ditch and dyke across the middle – but the ground was firm. Surprisingly the contractor offered it without rent and promised to lend all his men to clear the field. Three days more and it was good enough. That Sunday nightfall of 8 June found the Vimy ready for a test flight; but the optimism of the Vickers team had been sadly disturbed in the afternoon when the four-engined Handley Page majestically circled St John's, threatening to be first across the Atlantic.

On Monday, only 13 days after the crates had been taken to Quidi Vidi, the Vickers and Martinsyde teams pushed the Vimy to the end of the short runway where a fortnight earlier the *Raymor* crashed. Alcock and Brown clambered abroad. Engines were run up. A run of 300 yards, and the lightly laden aeroplane took off. Half an hour later Alcock landed at his new air-strip, Lester's Field, and that evening cabled Vickers: 'Machine absolutely top hole.' Next day he found that the fuel for their crossing had become contaminated with rubber compound in the steel storage drums. Then the weather broke again: rain, rain and low cloud. From Britain came a cable: 'Weather perfect here please cable reason non-start.'

Throughout the next two days a gale blew – but Alcock managed to get replacement fuel. On Thursday the wind dropped sufficiently for a second test flight. Again the Handley Page flew over St John's. That evening the SS *Graciana* docked in St John's harbour with Maxwell Muller aboard.

Friday, 13 June, dawned grey with heavy rain cloud and strongly gusting wind. Nevertheless final checks were made, and using a standard bowser pump the Vickers was loaded to capacity with 865 gal of petrol and 40 gal of oil. This was some 1,000 lb overload. Unremittingly the wind blew in from the Atlantic.

Alcock and Brown went to bed early: long before dawn Alcock awakened to find the roar of wind had lessened. He scrambled into his 'civvies' and Brown dressed in RAF uniform. They reached Lester's Field by car shortly after 3.30 a.m. The sun was just rising. Weather reports were good, with prevailing winds westerly over the Atlantic. It was gusty, and

Using the thirteenth post-war Vimy built by Vickers, John Alcock and Whitten Brown take off from Newfoundland on 14 June, 1919, for the historic first ever direct flight across the Atlantic. With 865 gal of fuel the Vimy had an optimum range of 2,440 miles. (*Vickers Ltd.*)

the meteorological officer advised Alcock to wait a little. Preparations continued. A boy cycled up from Alcock's hotel with coffee and sandwiches. Brown lashed his cat mascot on a centre-section strut; Alcock had one called Twinkletoes given by Brown's fiancée, and stuffed it in his overalls. While they ate a brief breakfast one of the men tied a lucky horse-shoe under Alcock's seat. The wind still blew so hard that one of the tethering ropes fractured a petrol pipe, and it took a long time to repair. At one o'clock the wind was blowing a steady 30 mph, but would help the take-off. With a last word to Maxwell Muller and Fred Raynham, the Vickers pair scrambled aboard and started the engines after the postmaster had handed up a canvas bag containing 197 air mail letters. At 1.24 p.m. Newfoundland time they were ready to leave. Chocks were whipped away. Into the teeth of the wind the Vimy slowly lumbered across the rough ground, gathering speed. Every spectator was silent and tense. Only a 400-yard length was available, but the Vimy sailed into the air on a shallow slant with 100 yards to spare. It was 1.45 p.m., equivalent to 5.13 p.m. British summer time. They vanished low down. Nothing more was heard until the machine landed 16 hr 27 min later in Ireland at Clifden, County Galway, where it ran into a bog and turned on to its nose. *Daily Mail* reporters were quickly there to interview the jubilant Alcock,

who said: 'We landed in the softest part of Ireland, but really it is a wonder we ever got here, for our wireless was out of action within half an hour of starting because the armature arm connected to the windmill propeller broke completely off.

'After taking off we had to fly up a valley and got some very bad bumps. That was the only time I ever had the engines full out. We climbed quickly to our height of 1,000 ft and Brown set a course for the ocean on 124 degrees. We kept that until well into the night. At dark we were about 4,000 ft up, between two layers of cloud and could see neither sea nor sky. It was impossible to observe the waves to get our drift, so we stuck to our course until finding an open patch about 3 p.m. when we saw a few stars.'

'I got a cut on Polaris and Vega,' interjected Lieut Brown. 'I got my position line, and found I was about a point south.'

Capt Alcock continued: 'Brown gave me the new course of 110 degrees. We went steadily on until the weather started to close in again about 4 a.m. Nothing could be seen. There was an extremely thick bank of fog, and we began to have a very rough time. The ASI jammed at 90 mph through sleet freezing on it, so I did not know exactly what I was doing. It felt as if I looped-the-loop when by accident we did a steep spiral. We came down quickly until we saw the water very near. That gave my horizon again, and I was all right. Though only a few seconds had passed it seemed an age. The ASI began to work as the result of the dive, and we climbed again until on top of the fog, only to find banks of cloud. We went higher and saw the moon and one or two stars. We never saw the sun rise. We climbed to 11,000 ft, and it was hailing and snowing, covering the machine with ice. This was about six o'clock in the morning, and it remained like that until an hour before we landed.

'Judging we were nearing Ireland we came down and flew over the sea at 300 ft. It was still very cloudy, but we could see the sun as it tried to break through. At about 9.15 a.m., we suddenly saw the coast. It was

Alcock and Brown's historic flight ended with a nose-over in Derrygimla Bog Clifden, County Galway, Ireland, after a flight of 1,890 miles nonstop in 16 hours 27 minutes, thus winning the *Daily Mail* £10,000 prize. The machine is now in the Science Museum, South Kensington.

great! We congratulated each other, pleased that the job was over. Passing two little islands we got to an inlet of Clifden Bay, and when we saw the wireless mast we knew where we were exactly. We flew along looking for somewhere to land, and when still over Clifden village I saw what I took to be a nice field – a lovely meadow. We came down and made a perfect touch-down – but it was bog. The wheels sank axle-deep, and the Vimy toppled on her nose.'

The whole world joined the British in congratulating the two airmen. In the manner of royal protocol Maj-Gen Sir F. H. Sykes received a telegram: 'The King was delighted to receive your welcome announcement that Capt Alcock and Lieut Brown have safely landed in Ireland after their transatlantic flight. His Majesty wishes you to communicate at once with these officers and convey to them the King's warmest congratulations on the success of their splendid achievement.'

From Handley Page came quick intimation that Admiral Mark Kerr had intended to make his transatlantic flight on the same day as the Vimy 'but the radiators were found defective and further delay was necessary. The radiators have now been replaced by others sent from England and an early attempt at the flight may be expected'. Meanwhile Fred Raynham had almost completed repairs of the *Raymor*, and a new navigator, Lieut Biddlescombe, arrived from England to replace Capt Morgan who was still very ill in hospital.

On the day that Alcock had left the murky shores of Newfoundland, the British rigid airship R.34 was making a trial night flight from East Fortune, where it was being prepared for a cruise across the Atlantic. During the

The crew car of airships as big as the R.34 was fairly capacious, though extremely lightly built of aluminium and duralumin. The ground crew act as shock absorbers to prevent the buoyant airship bumping on the ground in slight gusts. (*T. Elsemore.*)

six hours of navigational exercises it was found that wireless contact could be maintained with the Azores 1,200 miles distant. There was every promise of rivalling Alcock's success; but it seemed to critics that the tremendous cost entailed for a transatlantic airship flight belied the excuse the Treasury had made only a few months earlier that they could not countenance the cost of sending the Felixstowe Fury to Newfoundland for a similar attempt.

Like Hawker's and Mackenzie-Grieve's return to London, that of Alcock and Whitten Brown was a royal progress. Every stopping place gave a tremendous welcome, and there were municipal receptions at Chester, Crewe, and Rugby – while at Euston, where they arrived on 17 June, the Mayor, Ministry officials, the key management of Vickers, and a great concourse of people welcomed them. One of those present was General Sir Capel Holden, the chairman of the Royal Aero Club, who had urged authorization of expenditure on Cody's machine in those almost forgotten days a mere 12 years ago when no man in England had yet learned to fly.

Winston Churchill, Secretary of State for Air and President of the Air Council, presents the £10,000 cheque to Alcock and Brown after a great and felicitous speech at the Savoy Hotel, London.

20 June saw pilot and navigator at a great lunch at the Savoy arranged by the *Daily Mail* who were splendidly cashing in on the foresight they revealed before the war in offering the £10,000 prize. Winston Churchill, in his capacity as Secretary of State, honoured the occasion by presenting the prizes, which with subsidiaries totalled £13,000. In a typically Churchillian speech he said: 'The flight is an event which shows that, while we have become more powerfully equipped in all that sort of apparatus, we have also preserved as a race the audacity, the courage, the physical qualities of the old heroic bygone times. By this achievement we are able to see, we are able to assure ourselves, that our civilization has

combined the science of the 20th century with the virility and love of adventure of the knights of old – and let me add, it has been done with a modesty and courtesy worthy of ancient tradition, and probably far superior to ancient practice! It is more than 400 years since Columbus discovered America; it is only 10 since Blériot flew the English Channel – but it is not so safe and easy as it sounds to fly the English Channel. Yet think of the broad Atlantic, that terrible waste of desolate water, passing in tumult in repeated and almost ceaseless storms, and shrouded with an unbroken canopy of mist. Across this waste, through this obscurity, were two human beings, hurtling through the air, piercing the cloud and darkness, finding their unerring path in spite of every difficulty to their exact objective across those hundreds of miles where they arrived almost on schedule time. At every moment this voyage was liable to destruction from a drop of water in the carburettor, or a spot of oil on the plugs, or a tiny grain of dirt in the feed-pipe, or from any of the other hundred and one indirect causes which in the present state of aeronautics might drag an aeroplane to its fate. When one considers all these factors I really do not know what we should admire the most in our guests – their audacity, their determination, their skill, their science, their Vickers Vimy aeroplane, their Rolls-Royce engines, or their good fortune! All were necessary, and all contributed to their achievement. They are the victors, and the only victors. It is no disparagement to the gallantry of Mr Hawker; it is no disparagement to the brilliantly executed exploit of the United States Navy, if we say in surveying the Atlantic flight made by Alcock and Brown, "This is it!"

'When we study these prodigious efforts which are being made by so many to traverse the Atlantic by air, to bridge the gulf of waters, to annihilate space and time which divide these great communities; when we see these intense, repeated, stupendous efforts, made from so many quarters, can we not feel that they also symbolize the attempt to unite, not merely in the sense of eliminating distance, but the attempt to unite into one harmonious association all those great communities of English-speaking free democracies, which, combined together, working in true comprehension and perfect freedom, constitute an absolute guarantee for their own safety, and the surest promise of a future advantage and security of the world?

'At the beginning of these few observations, I spoke of the deeds of our two guests to-day as being worthy of the knights of old. Why should there be only knights of old? Why should there not be knights to-day? These two officers in the war did their duty in a perfectly straightforward manner, suffering wounds, or captivity, as so many of their comrades have done. They would be the first to say that any personal qualities they may have displayed, or any personal risks that they may have run, are no greater than those qualities which have been the lot of their comrades in the Flying Services in the long-repeated months of peril and effort which have constituted the history of the Flying Services during the Great War. But no one has ever flown the Atlantic in a single bound before, and no one

will ever fly the Atlantic for the first time in a single bound again. I am therefore very happy to be able to tell you that I have received His Majesty's gracious assent to an immediate award of the Knight Commandership of the Order of the British Empire to both Captain Alcock and Lieutenant Brown.'

Neither had expected that reward, but next day they received the accolade from the King at Windsor.

That same day the Aerial Derby was flown at Hendon. A big crowd attended in public enclosures, private boxes, and parks for the many splendid cars present. It was a gay and Ascot-like sight, organized by the sure hand of Bernard Isaac, the business partner of test pilot Clifford Prodger, and now consultant to Grahame-White, for whom he was aerodrome manager in pre-war days.

In the hands of Capt Gathergood, ex-Martlesham pilot, the hastily converted D.H.4R with Napier Lion proved a winner in the 1919 Aerial Derby at over 150 mph.

Companies interested in sporting aviation had bestirred themselves to make the event an occasion, though at as little cost as possible to themselves. Martin Sharp records that this same motive brought fame to Frank Hearle at Airco. 'Joking about workshop engineers who stepped boldly in where aerodynamic angels feared to tread, he clipped the lower wings of a D.H.4, fitted oblique struts to the upper planes, and somewhat crudely installed a 450 hp Napier Lion. It gave more than 150 mph. Despite a rather inadequate radiator, this lash-up, effected in a matter of 10 days and designated the D.H.4R, won the Derby in the expert hands of Gathergood – a surprise for the mathematicians.'

A commentator said that the machine appeared to be dragged through the air rather than to float in the manner of D.H.4s. Inspired by the same idea of saving wing drag, Koolhoven had similarly doctored his neat white Bantam K-125, enabling Chris Draper to win second place in the sealed handicap, and fourth in the speed contest by flying at 116·78 mph.

Of the twelve contestants in the Derby only two were post-war types – the renamed Avro Baby demonstrator and two stubby Grahame-White Bantams. All others were adaptations of Service types, such as the Avro

After the surprising success of the crude D.H.4R a careful racing modification of a D.H.9A was made using single-bay wings of 32 ft span, but with the same power it proved slightly slower than the D.H.4R. (*Courtesy Firth Vickers Stainless Steels Ltd.*)

504K, D.H.4, D.H.9, Martinsyde F.4, Bristol Monoplane, and a Nieuport Nieuhawk sporting blue and white checks on fuselage and tail. Of these the elegant Martinsyde was considered faster than the clipped D.H.4R, but flown by Lieut R. Nisbet it came second. Undoubtedly the fastest of all was the Nieuhawk piloted by Lieut Leslie Tait-Cox, but in the manner of all Dragonfly engines the power expired half-way round the second lap. Later it was flown by Jimmy James in an impressive show of aerobatics. Even more fascinating to many pilots was the 'fancy flying' displayed by

With clipped lower wing, the racing B.A.T. Bantam looked a much more lethal device than the similarly arranged but bigger D.H.4R, and proved far slower. Certificates of airworthiness were not obligatory for single-seaters. (*Flight Photo.*)

Capt Hamersley with the Avro Baby. If engine and aircraft could be built for a reasonable price, here was the light sporting machine of the next decade if low running cost was the only criterion.

But the air was ominous with reverberation of the future. Zero hour for German ratification of the Peace Treaty was only two days hence. At 5.20 p.m. on the afternoon of 23 June they signed, with one hour and forty minutes in hand. That same day the Germans scuttled their surrendered Fleet in Scapa Flow. There was an incredulous wave of dismay throughout Britain and France. Coldly Admiral von Reuter accepted full responsibility, and like a good sea lawyer explained that the original surrender of his Fleet had been part of the Armistice terms, but because those were now superseded by acceptance of the Peace Treaty conditions he felt free to carry out orders received at the beginning of the war that no German ship must ever be surrendered.

In a spirit of vindictive retaliation, Lloyd George announced in the House on 3 July, during his formal statement on the signing of Peace, that the Members of the Conference had agreed to a Tribunal of Allied Powers sitting in London who would conduct the trial of the Kaiser, and that a demand would be made to Holland for his surrender. On all sides the House cheered and cheered.

CHAPTER X

NEW HORIZONS

1919 (*cont.*)

> 'Citizens . . . my advice to those present is to be premature in nothing, not even in progress. It is evolution and not revolution that we should seek. In a word, we must not be before our time. I have come too soon to-day to withstand such contradictory and divided interests as yours. Nations are not yet fit for union.'
>
> Jules Verne (1887)

1

'IF ANY mercenary enthusiasts expected the successful Atlantic flight to inspire a boom in aircraft and kindred shares, he must be very disappointed. The effect has been negligible, if not exactly nil,' wrote a financial correspondent. Caution was general, for to the surprise of many, prices were rising instead of falling, and the Chancellor was budgeting for still higher revenue. In June a great Victory Loan had been initiated which raked in £250 million. There was talk of the necessity of import duties.

But more than personal financial stringency deterred the public from investing in aircraft shares. Although people had been convinced first by the long-range air raids and secondly by recent joy-riding displays that flying was an effective reality, as yet few believed in the commercial soundness of aerial transport.

Yet triumph followed swiftly on the trail of Sir John Alcock and Sir Arthur Whitten Brown. Britain again attained a splendid first, for on 2 July the Air Ministry announced that the airship R.34 had left East Fortune that morning at 2.48 a.m. British summer time to cross the Atlantic. Maj G. H. Scott, the most experienced of all our airship officers was her commander, and Brig-Gen E. M. Maitland, chief of the Airship Department, was aboard. Two cruisers, *Renown* and *Tiger*, were patrolling part of the route 'in accordance with Admiralty routine'. On 5 July the airship reached Newfoundland, and over St John's parachuted the mails she was carrying. Next came an urgent message to the US Navy Department at Washington: 'Could a destroyer proceed, if required, to the southern end of the Bay of Fundy to take HMA R.34 in tow? Signed Commander Lansdowne, USN, for the Commander of the dirigible.' Apparently her fuel was almost exhausted. Two American destroyers were immediately despatched but the airship was able to proceed to New

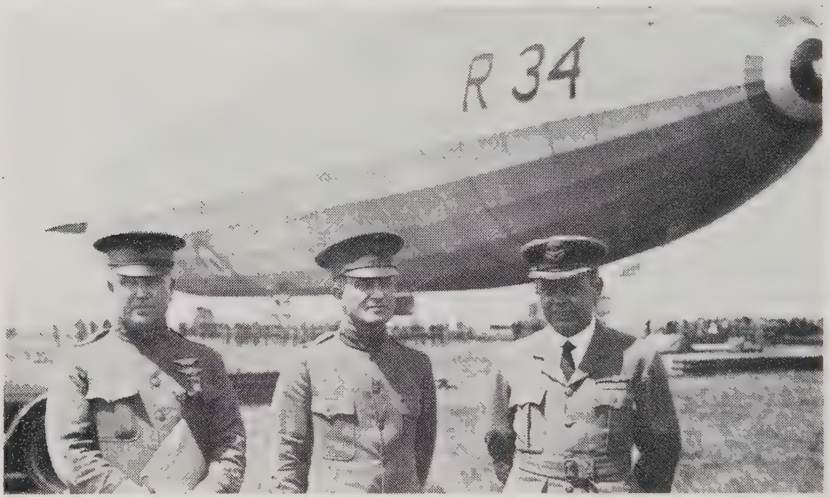
Sightseers watching the R.34 at Hazelhurst, Mineola, Long Island, after its completion of the first east to west air crossing of the Atlantic. (*T. Elsemore.*)

York under her own power, landing at the planned destination, Hazelhurst Field, Mineola, at 2 p.m. on 6 July.

She had cruised through fog much of the way, running wherever possible only on the two midship engines to keep fuel consumption within 25 gal per hour, giving a mere 30 knots. Said C. G. Grey: 'It is true that R.34 was only some six hours faster from shore to shore than the record voyage of the SS *Aquitania*, and one believes that she was considerably slower than the super battle-cruiser *Glorious* which took Mr Balfour to America in 1917, and is reported to have done the journey from Queenstown to Sandy Hook and back inside six days. But it must be remembered that the whole journey was an experiment, and no risks were taken. It was better to go slow and get there than to drive all-out through whatever weather might occur.' Experiment or not, the British public, long conditioned to the supremacy of Zeppelins, regarded it as a victory, endorsed to the hilt by the R.34's successful return a week later, having spent the interval secured to a mooring mast by a method devised by Maj Scott in the latter part of the war. Weather was too poor for return to her East Fortune base, so she was diverted to Pulham, Norfolk, where she landed at 7.57 after a flight of 75 hr 3 min. Describing the occasion, a reporter said: 'The ship was met by a motley crowd dressed in all possible varieties of Air Service uniforms – and there are many. There were men in RNAS and RFC and RAF uniform, others in civilian clothes, and some partly in uniform and partly in mufti.' In the new tradition there was an official welcome, when General Maitland, Maj Scott, and Lieut Shotter were met by representatives of the Air Ministry, RAF and Royal Aero Club – and

Mrs Winston Churchill, a friend of the Maitlands, was also present with Lady Drogheda, the Irish supporter of the Air League.

Commenting on British expectation of establishing lines of passenger-carrying dirigibles, the *New York Times* warned: 'John Bull is hard-headed and business-like. He is set on being master of the air. What is Uncle Sam going to do about it?'



With the R.34 safely moored, her commander Maj G. H. Scott is welcomed by the Officer-in-Command of the Hazelhurst base, but has to explain that he had an unauthorized stowaway aboard. At that time the USA had no big rigid airships. (*T. Elsemore.*)

Vickers spent much time investigating the possibility of such services, but belief in the airship as a real rival of commercial aeroplanes was discounted by most aircraft manufacturers. More directly it was the experience of constructing them which was of great value, and much had been learned of the danger of corrosion in the slender metal strips used to build up the transverse hoops and longitudinal girders.

Wooden aircraft had filled their purpose well for quick and rapid war production, but the increasing timber shortage had been a clear pointer to the necessity of metal construction, particularly for larger aeroplanes or where greater durability was essential. Considerable attention had been focused on a recent lecture by Dr Thurston in his new capacity as civilian consultant, but based on war-time experience as head of the Metal Design Department of the Air Ministry. He reviewed the whole field of metal development of biplane wing structures, and indicated that fuselage design would follow a similar pattern of built-up thin steel sections fabricated into conventional girder structure, or metal tubes might instead be used as pioneered by Vickers and the Royal Aircraft Factory before the war. Like many others, he was unaware of the secret experiments Oswald Short was conducting on monocoque duralumin stressed-skin shells.

'A year ago over 1,000 welded fuselages had been used with success in the fighting line, but not one had been made in this country,' he said. 'Had the war extended into this year we would have produced a prodigious number of machines, made of steel and duralumin, exquisitely designed for their functions, which would have swamped the enemy beyond all hope – so great are our still undeveloped sources. The Armistice stopped this. It will probably take 10 or more years now before metal construction will reach the state of development it would have attained in 10 months under war conditions. It is hoped by drawing attention to the problem and placing information at the disposal of firms interested, to hasten development of this important industry. Our position as a nation depends so much upon our status in the air that we cannot afford to neglect so important a subject. Ultimately all large machines will be of metal, and no aeronautical firm can afford to neglect such construction.

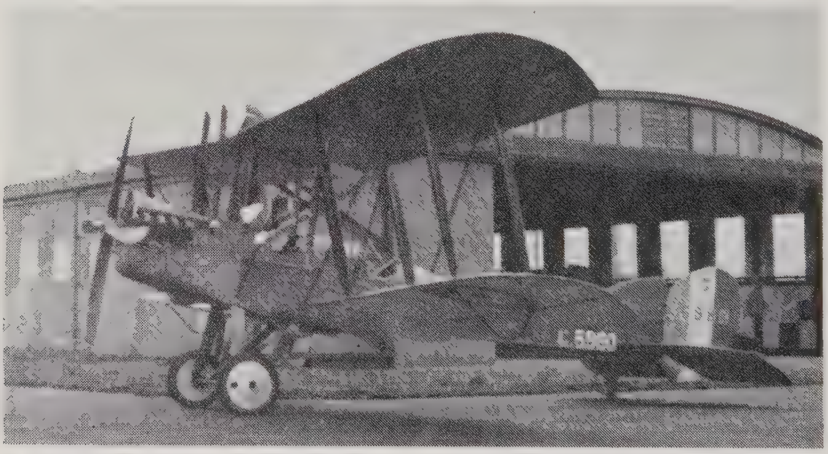
'It may be argued that metal is too heavy to construct efficient flying machines. The same argument was used in the early days of iron vessels; now wood is used only to construct small craft, and all large vessels are steel. I shall show that steel and duralumin are stronger than wood, weight for weight, and that the vital members of our flying machines can be, and have been, made lighter and stronger in metal than in wood. As a matter of fact the strongest flying machine yet made by any Power, as proved by loading until broken, is a duralumin Avro constructed by Vickers, and it is lighter than the standard wooden machine.'

After proving mathematically the value of metal construction, but ignoring the question of cost, Dr Thurston narrowed his argument, in the interest of time, to wing-spar design and the relative merits of hot- and cold-rolled thin steel strip compared with duralumin which could be three times as thick for the same strength. He added in coincidental but unwitting support of Oswald Short's view: 'Prejudice appears to exist in certain quarters against duralumin owing to the fear of corrosion. It should be stated that duralumin, unlike aluminium, is not acted upon by sea water, or affected by atmospheric influences, and experience in connection with airship work shows that duralumin, if properly varnished, is not affected by corrosion under ordinary conditions of service. Nearly every case of corrosion so far experienced has been due to incorrect heat treatment, or to cold working after heat treatment.'

As basic example of steel application he selected the Rudge spar developed from designs placed at that firm's disposal by Major H. N. Wylie when Lieut-Cdr RNAS, who recently had joined Major Green at Armstrongs. The first spar of this design was a thin-gauge steel box with externally edge-riveted flanges and webs longitudinally corrugated to prevent secondary failure, and three variants had been developed. Humbers based their much simpler 26-gauge steel box spar on a design originated by Major Green; and Dunlop, by substituting spot welding for riveting, had produced the cheapest and simplest spar which emerged from the assembly machine at 9 ft per minute – an incredible rate compared with other

methods. Meanwhile Vickers had developed built-up duralumin spars using stabilized plate flanges with lattice webs each side, adapting airship practice originated by their Barrow general manager, H. B. Pratt, and chief designer, Barnes H. Wallis, under the direction of Commander Craven, based on a suggested design placed at their disposal by Professor Lea of Birmingham University.

As the result of their war-time work at the Air Ministry both Dr Thurston and his late assistant Major Wylie had taken out a number of patents, but it was D. J. Mooney, managing director of the Steel Wing Co Ltd of Gloucester, who swept the board with more than 30 patents to date. James Mayrow, originator of the enterprise, now owned a competitive company. In the middle of the war the Steel Wing Co had valuable co-operation from the Sheffield firm of Kayser, Ellison & Co Ltd, in producing strip steel suitable for aircraft construction, and in 1917 gained its first success by producing an all-metal wing for the B.E.2e, employing T-shaped steel sections for the flanges and double-corrugated webs of aluminium alloy. From it was developed an improved wing intended for the B.E.2d, but the machine was already obsolete, so the firm was diverted to an urgent set of all-steel wings for the metal M.R.1 biplane. Like other metal wing companies, they also built a set of steel wings for the Avro 504K which were 'as light as the average wooden wings'.



A standard Denny-built B.E.2c fitted with two-bay B.E.2c wings with metal structure and fabric covering. These wings were evaluated under heavy manoeuvring loads by Martlesham test pilots. (*G. Kinsey.*)

But the old biplane formula persisted. O'Gorman's pre-war argument in its favour had become Gospel. The necessity of using metal to replace currently conventional structural members seemed clear enough, yet there was no official push to adopt the metal-covered deep cantilever wing originated by Junkers in Germany. An example was currently being prepared for loading to destruction at the Royal Aircraft Establishment, yet none except Frank Barnwell from Bristol and Robert Bruce from

Westland seemed interested in witnessing tests of such a complicated multi-spar wing.

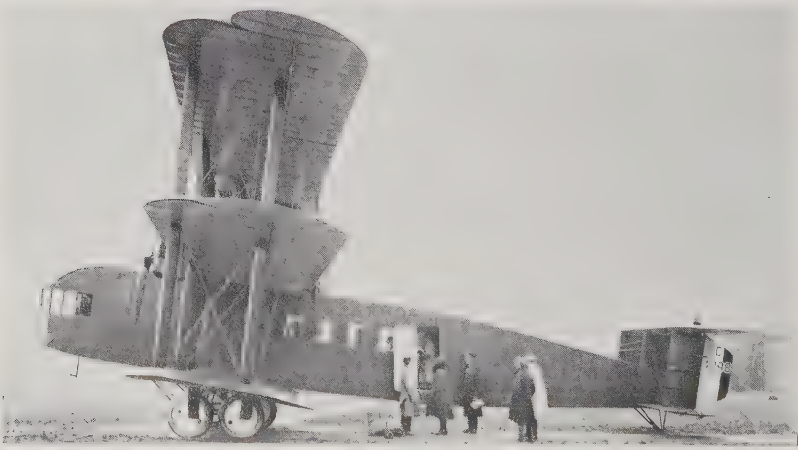
There was no clear pathway for the British aircraft industry, whether for metal or wood construction. Only Handley Page seemed ready to press vigorously ahead and cash in on his war-time renown, forcing the establishment of civil airlines using his machines, and setting up agencies and allied companies across the world. The passing months were making it only too clear that companies must either diversify or tremendously contract their manufacturing and design facilities. Yet there had been valuable side benefits. Before the war Britain was dependent on overseas supplies for ball-bearings and magnetos. War led to their manufacture by this country on colossal scale and the establishment of companies who could meet every future engine demand, whether for automobiles, industrial powerplants, marine engines, or aircraft. A host of other industries had also been created for the production of instruments, aperiodic compasses, radiators, electrics, cameras, wheels and tyres, and even textiles for which manufacture had been diverted from Russia to Ireland. Here was gain in the national product which in dispassionate view might balance the future small productive value of the aircraft industry yet did nothing to alleviate its problem of sheer existence. In Asquith's historic words one could only 'Wait and see'.

Except for Sopwith, designers of the bigger aircraft companies were hopefully filling in time by formulating grandiose 'brochure' civil airliners often of magnificent size. They dreamed that the great transport companies of the world would be interested in turning from ships and trains to swift aircraft. Because of the interest by the Royal Mail Steam Packet Co in ocean-crossing aircraft, Bristol engaged Major Vernon – who with Major Rennie had been Porte's assistant – as technician in charge of the design of their huge triplane flying-boat, using the Porte-type hull with which he had become so familiar in constructing the Felixstowe Fury. Even larger was a twin-hulled 160 ft span triplane flying-boat airliner which Francis Webber was designing under the watchful eye of Oswald Short, based on Oswald's patent, No. 131,045 of 1918, supporting the tail with metal booms rigged to the hulls, like the Curtiss NC flying-boat. This catamaran arrangement had been logically adopted to give marine stability and safety on Oswald's insistence that the wings outboard of the hulls should be jettisoned if weather or failure of the triple 600 hp Rolls-Royce Condor powerplants forced the machine to alight in mid-ocean. David Nicholson at the Gosport Aviation Co Ltd, was considering an equivalent airline version of the Felixstowe Fury, and Dick Fairey lost no time in making it known that he believed strongly in the future of civil maritime aircraft, particularly flying-boats such as the very large Titania biplane for which his company had designed the multi-engined wing structure for attachment to the big Linton Hope hull which May, Harden and May had recently completed at Southampton in 13 weeks using three boat-builders, five joiners and two apprentices. Concurrently *Engineering* reported that

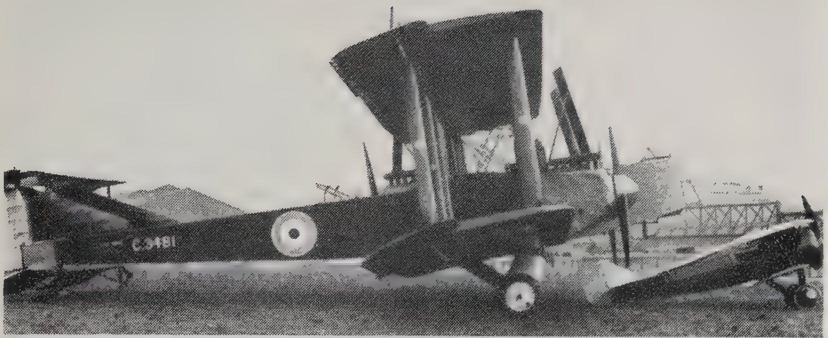
N129, the Fairey Titania with four Rolls-Royce Condor engines in tandem pairs. Fairey built the Titania to meet specification RAF XXII (XN4) for a big four-engined flying-boat capable of open-sea work.

Vickers were designing a very large seaplane, built entirely of duralumin, which would have a tare weight of 20 tons with disposable load of similar amount.

Of very large land aircraft there was similar proliferation of studies though somewhat less ambitiously, and in the case of the Bristol Braemar, Grahame-White Ganymede and the Siddeley Sinaia, conversions were actually made of bombers intended for the 1919 offensive. Already Airco was discovering little interest in the big twin Condor-powered D.H.17 which had been partly designed by Arthur Hagg under de H.'s jurisdiction and resulted in a particularly clean wide-span biplane with trousered undercarriage, and a fuselage deep as the wing gap, with the pilot sitting above the forward portion of the cabin where he had a most effective view. Both Brig-Gen Francis Festing as managing director of Aircraft Transport



Following the Armistice, official permission was given to complete the third Bristol Braemar with a cabin fuselage filling the gap between the two lower wings, and it had the first full crew enclosure of post-war airliners. (*Courtesy C. H. Barnes.*)



The Grahame-White E.I V Ganymede long-range day bomber had tractor engines in the twin fuselages and a pusher engine in the short centre fuselage. The Ganymede was designed to take 400 hp Liberty engines and have a speed of 120 mph, but was actually powered by 270 hp Sunbeam Maoris. (*Cuortesy C. H. Barnes.*)

and Travel and Lieut-Col O'Gorman as technical adviser to Airco were stating the case for smaller aircraft initially.

At Cricklewood, following conversions of O/400s for his projected airline operations, Handley Page was similarly dismissing earlier rosy hopes of super-big aircraft and considering a more traditional machine of much smaller dimensions having something of the appearance of the big V/1500, though with relatively longer fuselage and monoplane tail. It was the eighth which Volkert had drawn for a twin Napier Lion powered 12-seater.

The disastrous end of Britain's largest aeroplane, the Tarrant Tabor triplane, had given more than sufficient reason for its earlier critics to say 'I told you so', and began to check further interest in building huge and expensive prototypes. In a mere few seconds the work of more than two years had gone, and neither the Air Ministry nor the constructor felt confident enough to rebuild the machine, for the accident investigation

Handley Page made a triumphant start with a civil aircraft order for six O/400 (Type O/7) 10-seaters for the Chinese Ministry of Communications. Long nacelles housed fuel tanks behind the engines. The first machine is shown ready for test at Cricklewood, before shipment to China where it was flown, at Peking, on 6 December, 1919. (*S. T. A. Richards.*)

revealed conflicting interpretation of wind-tunnel results carried out independently by the NPL and the RAE. The atmosphere of doubt became increased when General Brooke-Popham claimed that the full investigation report should not be divulged. Nevertheless it was learned that Ogilvie & Partners, consulting engineers to Mr Tarrant, had taken such serious view of the RAE results before the attempted flight that they told him the machine was not safe to fly as the figures indicated the machine was so tremendously tail-heavy that it required 20 degrees deflection of the top elevator.

Tarrant had therefore called at the Air Ministry and 'discussed the matter with certain officials who had apparently received the results of the NPL tests, and who satisfied him that the conclusions derived from the RAE tests were false, and who therefore arranged to test the machine on the following Monday morning'. However, somebody of unrevealed name had managed to get that unnecessary 1,000 lb of lead ballast placed in the nose. In the Aeronautical Engineering Supplement to *The Aeroplane*, Capt Sayers commented: 'Apparently the NPL tests gave widely different results from the RAE, but the conclusions drawn from them were not allowed to appear. Whether they were equally wrong, or whether they were proved to be correct by the accident but were erroneously interpreted, or merely ignored by the responsible officials of the Technical Department, cannot be known. But it is difficult to avoid suspicion that "the public interest" alleged to be served by refusing to disclose results of the official enquiry is that of maintaining some fragment of reputation for the departments and officials implicated in the affair.' Even the jury at the inquest on the two pilots in recording 'Accidental Death', added a rider: 'We feel unanimously of opinion that something has not come out which should come out. We have not had the evidence of anyone in the machine, and we feel that something has been kept in the background that we should know.' But that seemed the pattern of all official enquiries.

2

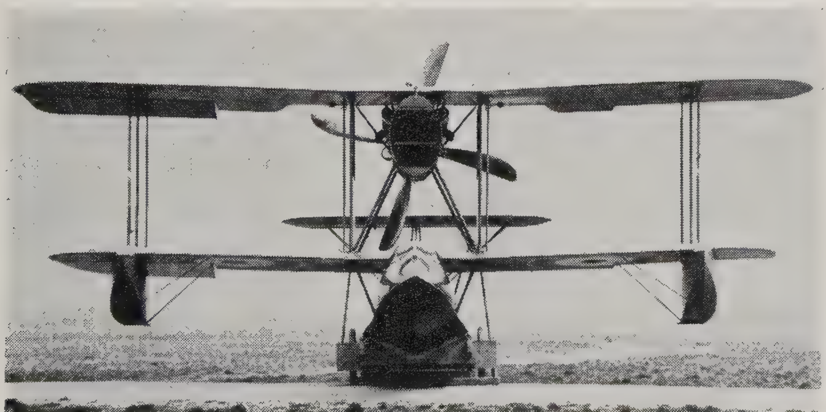
There was contemporary warning from Lord Weir of Eastwood: 'The rapid and quite abnormal growth in the technique and application of aircraft under the stress and artificial conditions of war-time must now give place to the more sober rate of development of peace-time. Our peace-time Royal Air Force, as I visualize it, will become a relatively small organization of remarkable efficiency with the highest ideals and the keenest *esprit de corps*. Its *matériel* should represent the last word in technical progress such as can only be achieved by considerable expenditure. Quality must be the key-note of its policy not only in *matériel* but also in personnel. An outbreak of war must see us with the very best designs of engine and aircraft, tried and tested, and with a manufacturing nucleus on which war production may be readily expanded.

'In regard to civil aviation, one factor is clear and definite. Our Government must accept the heritage of war experience, and by action, support,

and sympathy, encourage and develop its translation into the new channels of peace requirements. In technical development of design our Air Ministry must spend money by development contracts, as private enterprise will not be able to support developments for some considerable time.'

Some manufacturers certainly were ready to gamble. Announcement of the post-war return of the race for the Jacques Schneider International Trophy, so convincingly won by Howard Pixton with the Sopwith Tabloid seaplane before the war, was welcomed as affording opportunity of showing what this island of sailors could do in the light of their experience with flying-boat and seaplane design for anti-submarine patrols. It might lead to a valuable naval type as had the Tabloid in guise of the Baby. Entries must be received not later than 31 July, accompanied by an entry fee of £20. The contest was to be on Wednesday, 10 September, at Bournemouth; but the venue immediately created opposition, for there was only an open beach which would be difficult for launching, and the unsheltered sea could be very choppy in a breeze. 'Bournemouth is difficult to reach by road and a hopeless place in which to find lodgings during the holiday season,' growled C. G. Grey. 'The idea of housing competing machines at Cowes and asking them to fly all the way to Bournemouth, with attendant risk of collision with yachts in the Solent, is as foolish as could well have been conceived. In fact, the Royal Aero Club seems to be doing its best to make the event a failure instead of a success. It has not distinguished itself in the past by its intelligence in handling matters of real importance to British aeronautics.'

There was all too little time to design a new contender, but both the Sopwith and Avro companies decided to have a try, and Hubert Scott-Paine proposed to get hold of the Supermarine N.1B Baby fighter, of which the fore hull had been considerably modified for cleaner water



Front view of the Supermarine N.1B Baby does not reveal a particularly clean machine, though a speed of 117 mph had been recorded with a 200 hp Hispano-Suiza, so with a Napier Lion of more than twice the power it was expected 140 mph might be attained. (*Fleet Air Arm Museum.*)

performance since its first flight in February 1918. At the Armistice new wings of greater span, having balanced ailerons, were being constructed, so these would be finished and fitted under the care of the works manager's keen young assistant, R. J. Mitchell, and the machine would be repowered with a 450 hp Napier Lion instead of its 200 hp Sunbeam Arab. In view of its engine the new machine was named the Sea Lion. As a similar long shot at racing, Dick Fairey decided to enter the second prototype Fairey IIIA which had his patent camber flaps, but for the moment kept it dark that he would clip the wings from 46 ft to 28 ft, and would also install a 450 hp Lion.

Last of the Sopwith war-time fighters was the Snapper. It was originally proposed with a monocoque fuselage but reversion to conventional structure delayed it until the spring of 1919. With modified cowling and a spinner it was entered in the Aerial Derby. (*Flight Photo.*)

In June's Aerial Derby the Air Ministry had refused to allow Hawker to participate with the Sopwith Snapper because it had the 'secret' A.B.C. Dragonfly engine, so contact was established with Roy Fedden for the loan of a Cosmos Jupiter for the Schneider. With their usual remarkable speed, the Sopwith designers, still led by Herbert Smith, swiftly produced working drawings for a modern version of their pre-war entry, repeating precisely the original chord and gap of 5 ft 2 in and 4 ft 6 in respectively, but with a rounded fuselage reminiscent of their later 1914 Gordon-Bennett Racer. Some said that a standard war production Sopwith Baby seaplane had been taken, strengthened and faired, and the wing-tips squared off to give a span of 24 ft instead of 25 ft 8 in. The laden weight was 2,000 lb compared with 1,715 lb for the standard Baby.

Roy Chadwick at A. V. Roe took a somewhat similar line of attack. His basis was the new Avro Baby, and the resultant machine was almost dimensionally the same, but with stagger eliminated to bring the lower wing forward and thus get the C.P. in the right relation to the more forward C.G. caused by installing a Disposal Board 240 hp Siddeley Puma. All-up

The new prototype Avro Baby, K-131, had the same engine as the original, and flew in the Aerial Derby on 21 June, 1919, averaging 70·3 mph. In July it won the Victory Trophy at 77 mph, and in August was flown nonstop by Hamersley from Hounslow to Brussels in 2 hours 50 minutes. (*R. Chadwick.*)

weight was fractionally less than the Sopwith, though well over twice the weight of the genetic Avro Baby.

Meanwhile lesser aircraft companies were finding it impossible to survive. In mid-July the London and Provincial Aviation Company, who owned Stag Lane aerodrome at Edgware, announced they were retiring from business. During the war their owner-pilots Warren and Smiles had taught 550 Service personnel to fly with only a single fatal accident. Using a 50 hp Gnome powered derivative of the two-bay biplane designed for them by Tony Fletcher in 1916, they had expected to continue offering tuition and five were registered for use, but the Department of Civil Aviation refused to grant a certificate of airworthiness, largely because of the Gnome – though this safeguarding action was not unreasonable as the L & P Co intended to cash in on the joy-riding vogue by operating from dangerously little fields in Ireland. Nevertheless, Messrs Warren and Smiles, angry though they were at the DCA decision, knew they had potentially valuable land in their flying field at Stag Lane.

A Norman Thompson N.T.2B in trouble at Calshot. As replacement for the French F.B.A. many were built by Supermarine, S. E. Saunders, and the parent company. This boat had negligible spray trouble and was the only enclosed aircraft in service. (*T. Elsemore.*)

Even the Norman Thompson Flight Co Ltd had to go into voluntary liquidation despite valuable war-time contribution in which their own designs of flying-boat had proved so successful that S. E. Saunders and Supermarine were glad to build them as sub-contractors – but without F. P. H. Beadle, their pioneer-designer, the company had lost its dynamic impulse. It was reported: 'The Works are some six or seven miles from Bognor but there are practically no transport facilities. The new buildings, erected at the command of the Government, have never been used. Owing to cessation of hostilities there is a great drop in the value of aeroplane stocks, and the company has much material on hand which it is feared would not realise much at break-up prices. Nevertheless there is a surplus of £27,837 available for distribution among Debenture holders subject to the expenses of liquidation.' But Mr Handley Page had his ear to the ground. With no great generosity he offered 3s in the £ to the creditors, but to no avail. In any case he had other prospects and was ready to sink war-time profits in any business which might enlarge his scope. Only recently he had formed Handley Page Ltd of America.

With demobilization a few fortunate ex-RAF personnel had obtained positions with established aircraft companies. Handley Page had taken not only Lieut-Col Sholto Douglas, but also Major John Babington, DSO, Major Brackley, and Major Tryggve Gran, the Norwegian navigator of their Atlantic entrant. Shorts appointed E. B. Parker, not to be confused with John Parker their pilot, as London representative because of his great experience as a flying officer in the Naval Wing, and he was joined by Major S. V. Sippe, DSO, one of the three heroes of the famous raid on Friedrichshafen in 1914. Shorts' Air Ministry overseer, Lieut W. Pitcairn Kemp, brother of their earlier pilot Ronald Kemp, was made works manager, and Major Oscar Gnosspelius, who before the war had designed seaplanes on Lake Windermere, and during the war was on the Inspection staff of the Admiralty Air Department and later Air Board, was placed in charge of structural testing, aerodynamics, and hydrodynamics. As a private side-line he built a little ornithopter which he unavailingly attempted to pedal into the air in the seclusion of Oswald's new Experimental Shop No. 3 which had been completed in March.

Martinsyde, like Supermarine, had its small quota; but A. V. Roe engaged a tremendous number of pilots under the charge of Lieut-Col G. L. P. Henderson, MC, AFC, who had become prominent in the air war of the Near East and Balkans, and with whom many of his old comrades, such as Capt Paddy Fagan, Lieut Sparkes, Capt H. A. Hamersley, MC, Lieut A. Storey, DFC, and that famous pre-war Bristol instructor, Commander Warren Merriam, AFC, were already employed at Hamble as demonstration pilots. They were matched at Airco by Major Hereward de Havilland, Capt H. J. Saint, DSC, Capt G. W. Gathergood, Lieut H. 'Jerry' Shaw, AFC, Lieut E. H. 'Bill' Lawford, AFC, and Lieut C. R. McMullin. Marcus Manton became their aerodrome manager at Hounslow. Holt Thomas next appointed a number of foreign representatives

including Colonel Harry Delacombe, another pre-war aviator. Sopwith Aviation and the British and Colonial Aeroplane Co had been more limited as free-lance pilots could fulfil their requirements, and Fairey Aviation opened the door only to Dick Fairey's closer friends, such as Lieut-Col Vincent Nicholl, DSO; but Boulton and Paul, Grahame-White Aviation, the Blackburn Aeroplane and Motor Co, and many lesser firms all had their quota of Service pilots and engineers.

Whether now employed in civil aviation or with permanent commissions in the RAF, pay was small: a commercial pilot was lucky to achieve £400 a year and a bonus based on flying time; a 2nd Lieut in the RAF earned only 18s a day; a Lieut-Colonel counted himself fortunate with £2; even a General achieved no more than £2,500 for all his responsibility in running an army. The Air Ministry followed a somewhat better scale and gave directors of departments £2,000 per annum, and deputy-directors first class £1,500 per annum, or of second class £1,200 per annum. Service officers at the Air Ministry received a bonus of £75 to £100 per annum above their full pay, which was a great attraction in the race for preferment; but draughtsmen in aircraft firms had insignificant salaries.

3

Not only were the give-away prices of disposal aircraft beginning to affect overseas aircraft markets, such as Spain, Portugal, and South America, but back payment of tax and uncertainty of Air Ministry contracts was weighing heavily with every aircraft company. Provoked by vital necessity of securing assured and profitable contracts, manufacturers were rigorously maintaining the secrecy of war-time activities in their individual efforts to scoop orders. The system of awarding contracts for new military types was one of the major difficulties. It was regarded as near fraudulent – for the Air Ministry put successful designs to open tender, with probability that a rival company which had spent nothing upon experimental and design work would quote a lower price than the originator of the aircraft concerned. This was provoking reaction against powerful aircraft consortiums. Major C. C. Turner, writing in the *Observer*, alleged: 'There is too much evidence of internal strife, which is certain to increase as the situation, owing to lack of Government encouragement, becomes increasingly difficult for individual firms. There are some who say this has been brought about deliberately. There is a struggle to secure absolute control by one monopoly working side by side with the Government establishment.'

This led C. G. Grey to speculate with interest which firm this was. 'Obviously one thinks of Mr Holt Thomas's group first. The Aircraft Mfg Co, Ltd; Aircraft Transport and Travel Ltd; Airships Ltd; The Gnome and Le Rhône Engine Co, Ltd; Peter Hooker Ltd; and perhaps a few more of which one is ignorant, make a formidable list of producing firms. And when one considers Major-General Brancker, Brigadier-General Festing, Lieutenant-Colonel O'Gorman, Mr Alfred Turner, and

sundry other ex-officers and ex-officials, one perceives a galaxy of talent which might well make a successful effort to secure a monopoly of civil aircraft transport.' Lest this should be construed as libel he added: 'But then again there is Sir Samuel Waring's group – the Alliance Aeroplane Co, the B.A.T. Co, and the A.B.C. Engine Co, and a few more; and a number of astute businessmen concerned therewith. Also there is the benevolent autocracy known as Handley Page Ltd. And there is a little affair called Vickers Ltd which has a few stray admirals, generals, officers of lower rank, any quantity of MPs, and several millions capital, which it can use to fight or to create a monopoly. And there is a concern named William Beardmore & Co Ltd which carries some weight. And another known as Armstrong Whitworth. Not to mention the variegated ramifications pertaining to Boulton and Paul Ltd, and the solidly compact Sopwith Co, Martinsyde Ltd and sundry others.'

When the war-time demand for aeroplanes ceased Bristols kept the Filton factory busy by building bus and car bodies.

Undoubtedly *The Aeroplane*'s editor was aware that neither Short Bros nor the British and Colonial Aeroplane Company were the target of Charles Turner's barb, for both were more interested in securing contracts for car- and bus-body building to keep their factory consistently employed rather than corner the aircraft market. C. H. Barnes, in his *Bristol Aircraft since 1910*, records that: 'Throughout 1919 Herbert Thomas was very active in seeking coach-building contracts from the motor-car industry, and eventually set up a production line of bus and coach bodies for the Bristol Tramways Company and saloon bodies for Armstrong Siddeley cars which lasted through the worst of the lean years. A different project in the sphere of motoring was a single-seat light car designed by W. T. Reid, called the Monocar.' Oswald Short similarly was negotiating contracts for motor-boats, lifeboats, and barges, but though he managed to find enough work to keep his full war-time strength of Rochester em-

ployees busy, he and Eustace had to sack 600 men at Shortstown as airship work at Cardington was being brought to a conclusion.

Holt Thomas could see the writing on the wall, for his great empire had become top-heavy. He was reverting as many of his ancillary businesses as possible to their original occupation. Peter Hooker Ltd were again turning to their specialized work on pumps, and the woodworking firms at High Wycombe were back at their old task of furniture-making. But that did nothing to fill his great Airco floor area in the Edgware Road. It was all very well to emphasize Airco's importance by advertising that 'America's huge Airco fleet totals 1,191 D.H.4s in commission and 842 in storage' – compared with respective totals of all types numbering 2,339 commissioned and 1,075 stored. Of the latter 1,053 were Curtiss Jenny trainers and Standard 4-Cs, and the rest of the active American fleet comprised only 27 Spads, 18 Lepère observation planes from France, and four Handley Page O/400 bombers. What was essential to Holt Thomas were substantial constructional contracts, or else there was no option but to close the factory in the near future even if he managed to keep Aircraft Transport and Travel a going concern. His health had not improved, and there was some dissension on policy among the senior management who had done so much to make his business a practical success. Early in August Hugh Burroughes, who had been with him since 1913, and had been instrumental in securing de Havilland's services, left Airco and resigned his directorships, including that of the Gloucester Aircraft Co Ltd, where considerable quantities of Bristol Fighters and Nieuport Nighthawks had been built.

He told me: 'From a conversation which I had with Holt Thomas after I left, he was obviously convinced that the Government had no constructive policy about the aircraft industry. The position in which the Gloucester Aircraft Company found itself was similar to that of all other aircraft firms. The Government's attitude was soon made clear – to cut out all war material expenditure as quickly and cheaply as possible. There were no redundancy payments in 1919. There was no sign of any policy of maintaining even a nucleus of design or development of manufacturing capacity and there was no break clause. The current phrase of those days was that the recent war "was a war to end all wars". Why prepare for another?

'The method of cancelling contracts was drastic and under control of gentlemen who wanted to get back to their own businesses as soon as possible. We were all told to stop work and submit our claims in a matter of a few weeks. In due course the company submitted its claims and settlement of the Nighthawk contract was made promptly and the factory immediately cleared to keep it going on other work. This was the achievement of David Longden. Many firms were not so fortunate. As part of the settlement, the company purchased Nighthawk components which were no longer required and for which it had to provide storage. Later these components became foundation of the many types subsequently produced. In the face of Government indifference this settlement showed

considerable courage on the part of the G.A.C. Board and A. W. Martyn and David Longden in particular. The remaining claims for the balance of the contracts affected by cancellation became the subject of a Petition of Right and were eventually settled, together with claims for Excess Profits Tax, again by the brilliant work of David Longden. In the immediate post-war period the directors' main concern was how to utilize the manufacturing resources of the parent company, the Martyn Sunningend Works at Cheltenham, until such time as fitting out new ships and new architectural decoration work could be started and enable Martyns to rebuild its pre-war cabinet business.'

The big F.5 four-seat flying-boat built and owned by Gosport Aviation had too high a seat-mile cost for civil use, for it was powered by two 350 hp Rolls-Royce Eagle engines. Power loading was 18·3 lb/hp, wing loading 9 lb/sq ft, and span 103 ft 8 in.

August brought heartening events. The first great post-war international aviation exhibition was held at Amsterdam. Although the Society of British Aircraft Constructors was luke-warm in encouraging participation because it had hoped to hold its own international show first, many British companies were eager enough to send aircraft for display at the ELTA aerodrome, by which designation the exhibition had been splendidly advertised, the initials standing for Eerste Luchtvaart Tentoonstelling, Amsterdam. Typically the British Government did nothing to sponsor this early opportunity of aiding overseas aircraft sales. There was the absurdity of the Air Ministry permitting the Gosport Aviation Company to fly one of their new F.5 production flying-boats to the Netherlands in ample time on 31 July, piloted by Lieut-Col Hope-Vere and Lieut Carnegie, carrying the works manager Mr M. H. Volk and Major David Nicholson as passengers, but because it had not been officially delivered to the RAF all demonstration flying was forbidden, and the big boat remained moored on the Ij, scarcely visible in the distance. With equal diligence the Air Ministry refused to allow the Boulton and Paul Bourges to visit Amsterdam, although it had been publicly displayed at Hendon so recently.

First to arrive at ELTA from England was the Handley Page V/1500, piloted by Sholto Douglas, but its heavy weight bogged it down on landing and only with luck and hard work did it get into one of the two big exhibition halls after telegraph wires, kiosks and triumphal pillars had been pulled down, but inside the building there was only room to open

Dashing in appearance and beautifully finished in white enamel, the two-seat 'sociable' 200 hp Wasp-powered B.A.T. F.K.27 was completed in June 1919 and intended as the rich man's sportplane of outstanding speed, but there were no takers.

one pair of wings. Next came Koolhoven's F.K.26 piloted by Chris Draper, carrying the designer and his wife who exited from the big black and white machine with studied publicity carrying many suitcases, rugs and coats. A few minutes later the B.A.T. Bantam landed and became the centre of great interest. Anthony Fokker suddenly appeared at the very moment Draper was restarting the engine for a demonstration. It had been known some weeks that this most famous of all war-time designers – British, French, or German – had resettled in Holland where he had opened a new factory. People of the Allies tended to regard the war-time Fokker with awe rather than admiration, but at this encounter the British pilot was determined to show just what a British fighter aeroplane could do. A tremendous display of aerobatics followed. Fokker was reported to have turned to Koolhoven and said: 'It is a good thing for us that those machines did not come into the war,' and afterwards he congratulated the pilot on his display. Said one of the witnesses: 'The future of the B.A.T. company lies in international commerical aeronautics, for the British Technical Department will never forgive Fritz Koolhoven for being a genius while the best men which the Department could produce were merely journeymen-designers – so the firm need never expect Government orders.' That did not deter Major Jack Savage, the commercial manager, pursuing every possibility, aided by Major R. E. Nicholl in charge of flying operations.

One of the stars of the show was Sir John Alcock, who demonstrated the new Vickers Vimy Commercial which Capt S. Cockerell piloted from England carrying Capt Acland and other management members of Vickers. Unlike the Handley Page O/400 which arrived later and stood on its nose after the wheels sank into the soft ground, the Vimy was saved

Earliest bid for the twin-engined airliner market was the prototype bull-nosed Vickers Vimy Commercial, pictured ready for its first flight at Joyce Green in April 1919. (*Vickers Ltd.*)

on several occasions from similar disaster only because of the auxiliary nose undercarriage. Within the exhibition hall a standard Vickers Vimy bomber was displayed, but appeared diminutive compared with the half-opened Handley Page V/1500. Airco had a D.H.4 with enclosed passenger cabin, and also featured a Napier Lion engine as well as many paintings of the Airco range. The British Aerial Transport Company displayed a Bantam and their diminutive and useless Crow monoplane which had

The miniature B.A.T. Crow followed the Santos-Dumont tradition in seating the pilot below the wings on the undercarriage frame, but despite its cantilever cleanness it had much heavier wing loading than the Demoiselle and proved useless. (*G. Quick.*)

been intended as a 'motor-cycle of the air'. Several British companies in the time-honoured way seemed to have misjudged the time it would take for exhibits to arrive, so that stands of Gosport, Blackburn, and others were empty – but at least there were plenty of hard working Le Rhône Avros joy-riding on the aerodrome, where queues awaited flights, and several Airco 4s and 9s arrived with distinguished passengers. For the first time British machines had their new G-E registration sequence instead of K numbers.

4

Though this international exhibition, with its great concourse of European visitors, had not been used to full advantage, an announcement on 14 August by Maj-Gen Seely, revealing that the Department of Civil Aviation proposed to offer prizes aggregating £64,000 for aeroplanes suitable for commercial purposes, had fundamental interest for every British aircraft constructor and afforded particular gratification to Handley Page as the sly instigator. Prizes were offered for three types – single-engined aircraft, twin-engined passenger airliners and amphibian seaplanes or flying-boats. Rules were published with no loss of time for a 'Competition for aircraft to further the attainment of safety of air travel'. Trials would commence on 1 March, 1920, at Martlesham. Conditions did not appear very onerous. Small types must be capable of 100 mph, the large 90 mph, and seaplanes 80 knots, with a minimum rate of climb of 500 ft/min for small types and 350 ft/min for large aircraft and seaplanes. Take-off and landing distances over a 50 ft obstacle would be tested in still air at full load; there would be reliability duration tests of $3\frac{1}{2}$ hr for small types and 7 hr for the large, but left open for seaplanes and emphasis directed instead towards safe low-speed behaviour and a 24-hr mooring-out test in fair weather.

Like the 1912 Military Trials, not only performance and reliability but design features would be considered and marked for 'soundness and quality of construction, such as fire protection using self-sealing tanks, reliability of systems and durability of the machine, particularly if there was any advantage due to metal construction'. General features were also to be appraised including: efficiency and ease of control; unrestricted field of view to the front for the pilot; silence as affecting the occupants; comfort generally, including warmth; self-starting devices; method of windscreening; convenient display of instruments; freedom of entry and exit for occupants. By implication, brakes were to be a feature, but extraneous methods were excluded – such as that used by Cody with his Military Trials machine when he dragged a heavy chain. The rules concluded with a hopeful note that: 'The Government will, if the entrant agrees, buy the machine winning the first prize, the design to remain the property of the manufacturer. The maximum price payable under this heading will be £10,000 for the large type, £8,000 for the seaplane and £4,000 for the small type.

'The following prizes are offered:

Small type – 1st Prize, £10,000; 2nd, £4,000; 3rd, £2,000.
Large type – 1st Prize, £20,000; 2nd, £8,000; 3rd, £4,000.
Seaplanes – 1st Prize, £10,000; 2nd, £4,000; 3rd, £2,000.

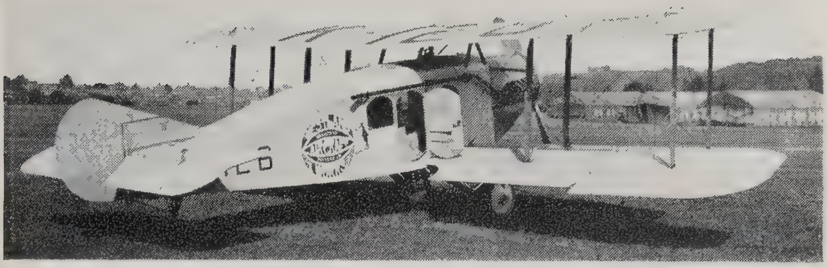
Entries close December 31st, 1919.'

There was immediate reassessment of the various small and large commercial aircraft currently completed or still on design boards. To all designers the classification of sizes seemed too limiting, for the small type was defined as having a total carrying capacity of two persons including the pilot, which seemed to offer no great commercial future, and the large type was to accommodate 15 persons exclusive of crew; thus medium-sized aircraft such as the B.A.T. F.K.26, and the new Westland Limousine, as well as such larger machines as the single-engined D.H.18 and the Alliance biplane, would not be admissible, nor in the larger class could the Vimy Commercial compete, though Handley Page's W.8 seemed to confirm foreknowledge as it was precisely the right size.

The new Westland Limousine had been test-flown early in July by Capt Stuart Keep, MC, BSc, an Australian who had joined Petters Ltd as chief test pilot in June – for this was one of the fortunate firms which still had a production line of D.H.9As as well as the balance of the Vimy contract of which earlier machines had been flown by Flt Lieut Rollo de Haga Haig.

Towards the end of the war it was clear to Petters that their Westland Works were outgrowing the modest premises, and in 1918 a big erecting shop was built with the longest single span then made. Vickers Vimy production continued there after the Armistice and later it was used for D.H.9A overhauls.

Although he was an engineering graduate, Keep considered himself lucky to have got the job among the crowd of ex-Service applicants, and some years later told me with a chuckle that after his interview he took off from Yeovil in his RAF Bristol Fighter so bemused with good fortune that he paid little attention to his compass course and in the evening mist became lost. After circling for some time he landed near a road to enquire the way, but when help came it was too dark to continue. Next morning, taxi-ing down-wind with his brakeless aircraft, he ran uncontrollably into a stone



The prototype Westland Limousine is shown on the small aerodrome at Yeovil. Painted dove-grey, with cabin trimmed in matching Bedford cord, the machine had considerable eye-appeal, but the modest cost of £2,000 was too great to compete against war surplus aircraft at cut prices.

wall and broke the propeller. By the time a replacement was obtained the weather closed in, and it was three days before he was able to take-off for his home station. Hourly for the next week he expected to learn that the eagle-eyed, penetrative managing director of Westland had heard of his peccadilloes and cancelled his one great opportunity to have a specialized flying job. But all was well, and in any case Keep's operational and technical attainments would not have been lightly dismissed because of a minor accident accepted as part and parcel of the pattern of those days.

The new Limousine was demonstrated on 31 July to the Press, who were brought to Yeovil by special train. For economy the prototype had a Disposal Board Rolls-Royce Falcon and a Bristol Fighter radiator, but though the machine had resemblance to earlier Bristol design, the details were typical of concepts established with the Westland seaplane N.16 originally known as W.1, the little Wagtail, and the Weasel two-seater. Experience of D.H.9A plywood covering led to similar construction for the four-seat cabin in which the pilot occupied the port rear seat partly partitioned from the passengers and raised high so that his head projected through the cockpit coaming. One passenger was seated alongside but lower, and could see the pilot's feet and hands manipulating the controls; the other two passengers were each side of the fore-part of the cabin, one facing forward and the other aft. Widespread publicity from the demonstration appeared in dozens of journals ranging from the *Engineer* to the *Daily Mirror*, and much favourable comment was made on the grey Bedford upholstery so reminiscent of a luxury motor-car: here was a standard of comfort never before seen in an aeroplane. Certainly the twin brothers Ernest and Percy Petter began to see a rosy future which delighted the cautious Bruce whose active mind was visualizing a twin-engined airliner with Limousine-type fuselage underslung D.H.10 fashion below Vimy-like wings, and he knew it would need all his tact to get the brothers to spend money on such a venture. Meanwhile the small Limousine required minor redesign of the vertical tail surfaces as there was slight directional instability, but results were so promising that John

Chandler, the works manager, was instructed to order materials for a batch of six. Concurrently, a supplementary contract was received to modify the third prototype Weasel to take the fourteen-cylinder 350 hp Armstrong Siddeley Jaguar now under intensive development, and the fourth Weasel was to be completed with a nine-cylinder derated 400 hp Cosmos Jupiter. Additionally, Westland was confirmed as the parent modification design source for the D.H.9A now adopted as standard peace-time equipment for the RAF. Well might Percy Petter tell reporters that his firm was determined to play an important part in future aircraft construction – for Robert Bruce's engineering concepts were sound, and he had devised several improvements on contemporary practice, such as the Westland patented adjustable tail incidence gear. First used on the Weasel, it eliminated the lost motion experienced with other tail gears, and utilized a worm and screw mounted horizontally between the lower longerons, from which was taken a triangulated tubular mounting to the tailplane, attached to a rotatable transverse shaft below the centre of the front spar and to a rigid pin at the rear spar. By moving the jack nut aft the geometry was such that the triangle swung upwards, thus decreasing the incidence of the tail without loss of structural rigidity.

The first Airco which de Havilland designed specially for airline work was the Napier Lion powered prototype D.H.18 tested by Capt F. T. Courtney. Like Koolhoven's F.K.26, the pilot was in an open cockpit behind the eight-passenger cabin. (*Flight Photo.*)

Progressively bigger and heavier than the Westland three-passenger Limousine of 38 ft span and 3,380 lb laden weight were the B.A.T. F.K.26 of about the same size as the 46 ft span D.H.16 and similarly carrying four passengers, the 51 ft span eight-passenger D.H.18 now under construction which had an estimated all-up weight of 7,000 lb, and the slightly larger eight-passenger Alliance biplane based on the transatlantic *Seabird* contender which at this point was entered for the Australian Government's £10,000 prize.

As a preliminary demonstration the Alliance, piloted by Lieut W. R. Curtis with its designer, J. A. Peters, aboard, had recently made a record flight from Hounslow to Madrid, achieving 900 miles in $7\frac{3}{4}$ hours. But

there were ominous signs that Waring and Gillow, owners of its constructing company, seemed heading towards financial difficulty, for although the big stores and its many subsidiaries had a trading profit for the last three years of some £1,200,000, the current dividend on preference shares was unpaid, and £42,500 was being written off for discounting and underwriting, leaving £942,050 subject to an estimated liability of £880,000 for Excess Profits Duty and Income Tax. Sir Samuel Waring and his directors were taking a hard look at their aviation activities, for there was not the slightest chance of securing Air Ministry orders particularly as their machine was too big for entry in the Commercial Aeroplane competition.

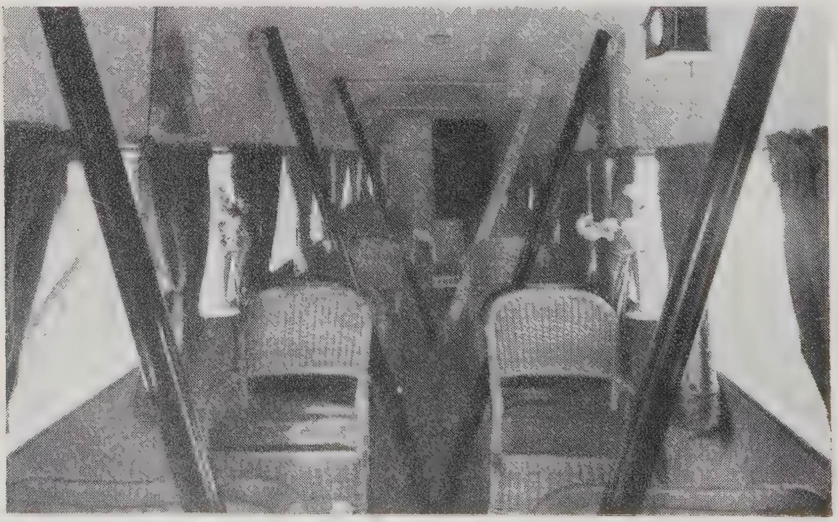
The Government was already being criticized for wasteful expenditure through retaining huge war-time depots such as the motor dump at Slough and the great shipyard at Chepstow, and this led to the appointment of a Select Committee to consider what munition factories and other warlike organizations should be kept. Ministers also faced nation-wide outcry against high prices, and before the House adjourned in August the Government had hurriedly to pass a Bill establishing controlled prices and county Appeal Tribunals. There still was registration and rationing, and the Chancellor of the Exchequer, Austen Chamberlain, was taking a very gloomy view of national finances. Among retrenchments made feasible by the tide of international politics was a Cabinet decision to withdraw British Forces from their Russian base at Archangel during the next month. The Bolsheviks were growing in strength and everywhere beginning to subdue those of their countrymen led by Admiral Koltchak, who was in retreat to Siberia, and his colleague General Denikin who was being driven back to the Black Sea. Meanwhile Lloyd George was pleased to find that the great millionaire philanthropist Andrew Carnegie, who died at the beginning of August, had left him a bequest of £2,000 a year for life.

Between the Western Powers and the USA there was increasing political tension in sustaining the League of Nations which Clemenceau, in opposition to President Wilson, wished to use solely to keep Germany subdued. America would not even accept the terms of the Treaty of Versailles. Vote after vote turned against Wilson, and the USA decided to refuse membership of the League of Nations although their President had largely architected its constitution. Yet in England there was strong backing for the League – but in any case we had secured a share of German reparations, rich interests in Mesopotamia, Palestine, and Africa, and recognition of separate representation of the Dominions in the League. So while to some the idea of nations welded in common purpose was a tool, to many idealists it spelled a new Utopia in Europe.

Certainly there were heartening signs that whatever the world problems, Britain was forging ahead with plans for commercial passenger airways. The Air Ministry announced: 'Pending the final signature of the International Convention a provisional agreement to allow flying between France and Great Britain from Monday August 25th has been arrived at between the respective Governments.'

Civil aviation in full swing at Cricklewood with Handley Page Transport's civil version of the O/400. Services were operated to Paris and Brussels and there was joy-riding. *(S. T. A. Richards.)*

At 9.10 a.m. on the opening day Holt Thomas's Aircraft Transport and Travel, which had a nucleus of four D.H.4As, despatched G-EAJC to Paris, piloted by Capt E. H. 'Bill' Lawford, on a positioning flight carrying a Press representative, newspapers, a consignment of leather, several brace of grouse, and jars of Devonshire cream, arriving at Le Bourget at 11.40 a.m. and returning an hour later as the first scheduled run from France. But the wily Frederick Handley Page had stolen a march with an O/400 from Cricklewood, piloted by Major E. L. Foot, for it arrived with a complement of 11 journalists at Le Bourget 1½ hours before the AT & T machine. The actual AT & T scheduled flight from Hounslow was made by the D.H.16, K-130 (later G-EACT), piloted by Capt Cyril Patterson, carrying four fare-paying passengers, and it arrived at Le Bourget at the same moment G-EAJC touched down again at Hounslow.



Luxury air transport for 1919. The Handley Page O/7 version of the O/400 was given V-transverse bracing and fitted with cane seats which had no safety belts. However, there were curtains and flowers in the window bays. *(S. T. A. Richards.)*

Holt Thomas announced that his machines would leave for Paris every day 'whether there are passengers or not, they will go to schedule time'. H.P. capped it with a regular service to Paris commencing 2 September, returning the next day, adding a similar service to Brussels from 23 September – and he gave Holt Thomas a further knock by undercutting the fare from 20 guineas to 15 and publicizing that O/400 twin-engined airliners would be used, and they accommodated 14 passengers. Aerial travel attained new hope. All over England the populace was being lured to try the pleasures of flying – for daily joy-riding was available, mostly in Avros, at more than 30 centres. Some 60 established aerodromes were open for civil use, and over 100 RAF aerodromes could be used by civil aircraft in emergency. Sixty more, including Joyce Green at Dartford used so long by Vickers, had passed to the Government Surplus Property Disposal Board and would be relinquished as soon as hangars and equipment had been removed. Currently the Air Ministry stated that in view of the decision of the Government to curtail the airship programme 'certain airships, airship stations and stores would be placed at the disposal of interested parties on terms to be agreed, with a view to the commercial development of this type of aircraft.' Sir Trevor Dawson, chairman of Vickers, had been gambling on this, for he contemplated using the R.80, which was under construction at Barrow, for airship tours of the battlefields as a preliminary to other services.

5

An announcement that Sir Richard Glazebrook, CB, FRS, would retire from directorship of the National Physical Laboratory on reaching the age limit on 18 September, and would be succeeded by Professor Joseph E. Petavel, DSc, FRS, was a reminder of the great lead Britain had established in aeronautical research and methods of accurate physical measurement. Issue of the 1918–19 Annual Report of the Advisory Committee for Aeronautics, long chaired by Sir Richard, necessitated three bulky volumes to encompass items of research considered of general technical interest, but others could not be published because of their secret nature.

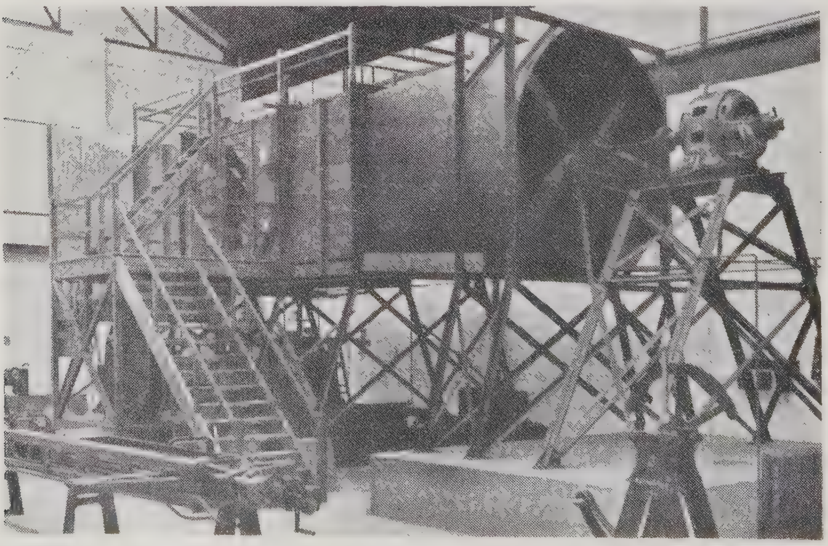
'While the war continued it was necessary to avoid including in the Report any information which could be of value to the enemy,' explained the Committee in addressing their prologue to the Rt Hon Winston Churchill, MP, as Secretary of State for Air. 'It appears desirable to revert to earlier practice, and it may be useful to attempt to give a brief account of the progress made in aeronautical research since the year 1914.'

By now the NPL and RAE had a dozen wind-tunnels between them, of which the largest was the NPL duplex with 14 ft by 7 ft cross-section. This had enabled a tremendous range of work to be carried out in the last five years, but the Report baldly stated: 'No great advance has been made in the design of new wing sections, although many tests have been made on special aerofoils designed for specified purposes or by firms for their own machines. A large number of tests have been made to ascertain the best

wing for a high-speed aeroplane. Experiments show that a thinner section than the RAF 6 previously used has much greater efficiency at low lift coefficients corresponding to an aeroplane's maximum speed. From these experiments, three aerofoil-sections were designed, and one, RAF 15, is representative of the standard section adopted for many aeroplanes. Of many others only one, RAF 19, is of note as it has the highest known maximum lift coefficient.

'A large number of model aeroplanes have been tested throughout the war with one of three objects in view: (1) To increase the knowledge of the corrections from model to full-scale work; (2) to report and improve on new designs of aeroplanes previously under construction; and (3) to ascertain the causes of accidents or of poor performance in the case of certain types. In addition spinning has been thoroughly investigated.

'One of the most important matters has been the stability of aeroplanes. Both experimental work and theoretical investigations have made great progress. Complete aeroplane models have been tested and their stability characteristics found, thus providing a useful accumulation of data. Study has been made of methods of calculating rotary derivatives by integration from knowledge of the lift, drift, and pressure distribution data, and formulae have been deduced which give results in good accordance with measured values. This will be of great assistance to designers, but will not entirely obviate the desirability of ascertaining by direct experiment on models of all radically new types their specific stability derivatives and characteristics. If manufacturers adopt the policy of submitting a model



The first manufacturer to use a wind-tunnel systematically was Handley Page with Northampton Institute facilities at Clerkenwell, London; but in 1917 he built a 4 ft tunnel at Cricklewood, and Airco built a similar one (above) at Hendon chiefly for airship research.

previous to the construction of the first machine, they will avoid many alterations later found necessary in most cases of prototype development and, there is good ground for believing, will be satisfied as to the safety and stability when flown for the first time. In every way conclusions drawn from stability investigations have been completely justified, and no cases have yet arisen from where the analysis of stability problems has proved insufficient to explain observed facts.'

In the course of the war, gradually it had been realized that the comparatively poor manoeuvrability of earlier machines such as the B.E.s was not entirely because of their stability but due to aerodynamic characteristics of their controls. Recently much research on control hinge moments and methods of balancing had yielded highly manoeuvrable aircraft. Small span was beneficial to quick and handy manoeuvring, though antagonistic to climb; therefore the accent on greater power, for the height at which fighting took place was a vital factor, and had gradually increased from year to year to 20,000 ft. It meant that throughout the war aeroplane designers were largely waiting upon the engine designers, for there seemed no way of hastening the minimum of 18 months between commencement of design and the beginning of reliable production engines. Only half as long was taken to develop and test a new aeroplane. The latest aim was not only to provide ample power for take-off, but to seek methods of maintaining power at height, for a conventionally aspirated engine of 300 hp would deliver only 200 hp at 15,000 ft. This, and fuel economy, additives of ethyl and alcohol to raise detonation limits, thermal efficiency, cooling systems, gearing, vibration, electrics, and many correlated problems were the subject of intensive research at Farnborough.

Even more important for the confidence of pilots was strength of construction. 'The recommendations made in 1913–14', stated the Advisory Committee Report, 'led to the adoption of a factor of safety of 2 where the stresses on the wing for the purposes of design are determined from calculations of the strength of the machine for a load equal to three times its weight. Some alteration in the basis of calculation has been found desirable during the war. For fast scouts the practice has been to design the machine for a load equal to seven or eight times its weight, while for heavy slow-flying machines four times the weight has been taken as the figure to be employed. The load factor to be adopted in the future, especially for civilian flying, is at present receiving consideration.'

In practice, an aeroplane could still be broken in the air by violent manoeuvring – for the actual factor of safety was only about 1·6 when the load factor was as high as 7 – but a practical ratio of strength to weight had been attained and could be calculated with considerable accuracy. The percentage total weight of the structural unit was remarkably consistent whatever the size of aeroplane, although this was attained in larger aircraft such as the Handley Page by reducing load factors because the machine would not be so violently manoeuvred as a fighter such as the Sopwith Camel. Thus a small aeroplane achieved a 31 per cent structural weight

ratio and an O/400 slightly under 35 per cent, but attained parity with the fighter because power unit weight was relatively less. It had been a major lesson to discover that the structural percentage remained substantially constant for aeroplanes varying in total weight from 1,000 to 30,000 lb, and by extrapolation there seemed little doubt that aeroplanes of 100,000 lb were feasible.

Indicative that cantilever wing design was being considered, and hinting at early computors, the Report stated:

'No less important is the work being carried out by the RAE on torsion of tapered members for evaluation of solutions to the linear differential equations occurring in stress problems, and a machine is being developed for solving a large number of simultaneous equations.'

Of more immediate importance had been the RAE's investigation of interference between the propellers of tandem-engine arrangements, as well as that of superimposed propellers, for the first was applied to the Handley Page V/1500, the Felixstowe Fury flying-boat, and the ill-fated Tarrant, while the second concerned double-rotor helicopters on a vertical shaft in a form offered to the Air Ministry by the Italian Marquis of Pateras Pescara whereby the turning effects due to torque could be eliminated by contra-rotation. Such a machine might well displace kite balloons for artillery observation – a possibility which had interested the Air Ministry's predecessors since 1916.

With the increasing size of engines from 50 hp of 1914 to current powers of 600 hp, and propeller speeds ranging from 500 rpm in airships to 2,200 in the latest aeroplanes, propeller design had become a major factor. Still based on marine design 'strip element' methods devised by M. Drzwiecki in 1882, there were now additional problems of vibration and variation of loading to be considered, as well as strength. A big engine could impose a centrifugal pull on the propeller roots of as much as 5 tons, and the thrust could induce a bending force of half a ton per blade. For a time it had been thought that the stresses would limit the maximum power transmittable through a single propeller, but research revealed that centrifugal loading could beneficially neutralize bending stresses. The current limitation had become tip speed, reaching as much as 880 ft/sec for the propeller used by the Liberty-engined D.H.9A, so gearing had become essential to keep tip speed below that of sound.

Engines had been subject to equally intense investigation as aeroplanes and propellers – perhaps more, for the Report indicated: 'Throughout the war, the development of engines with a view to production in quantity has always been the main question. The Committee were able to give advice on special points which arose from time to time. With the Sunbeam engine much trouble was initially experienced with defective castings, but this was overcome. With the Wolseley Hispano, crankshaft failures gave trouble, but an improvement of design overcame the difficulty.' Diplomatically, there was no mention of the apparently insoluble troubles besetting the A.B.C. Dragonfly except that 'several special questions arose during the

design of certain engines'. There were interesting references to a programme of 10 experimental engines laid down in February 1918, of which the last was a 600 hp four-star sixteen-cylinder weighing 2·2 lb per bhp, and there was veiled mention of 'differential' engines where the weight might be as low as 1 lb per hp.

Though application of light alloys to aeroplane construction had not received the same impetus as in Germany – where many patents had been taken out by Claudius Dornier and A. Rohrbach of the Zeppelin company – there had certainly been considerable research on their use in airship and aero-engine design. Since 1917 the Light Alloy Sub-Committee had dealt with 120 reports, and a considerable range of alloys of aluminium with iron and those of copper, nickel, magnesium had been investigated for strength, corrosion, and variation with temperature. Optimistically the report on this section concluded: 'In many matters the Germans advanced in the early days of the war much further than the British industries, but during the last two years such steady progress has been made that it is certain that in nearly all directions this country is considerably in advance of the enemy.'

This E.4/20 four-engined high-wing cantilever monoplane of all-metal construction was designed by Dr Adolf Rohrbach of the Zeppelin company towards the end of the war, and put Germany years ahead in precedent of future commercial aircraft.

But research was not only the prerogative of official institutions. There were other highly secret investigations being made in a new direction. Handley Page, that pre-war adapter of Weiss bird-shaped wings with heavily reflexed tips, had continued pondering over the relatively low value of contemporary maximum lift coefficients which necessitated very considerable wing area to get sufficiently low landing and take-off speeds to enable his big aeroplanes to operate from the customary relatively small aerodromes. From personal experience of wind-tunnel work he was aware of the character of what he described as the 'burble', or breakdown of flow at maximum incidence. Could it be delayed by some method of drawing replenished air from the under surface to the top and so steadying the flow as in the parachute he had watched? He decided to investigate with one of several basic, standard rectangular 36 inch model aerofoils of 6:1 aspect ratio, selecting RAF 15 section because its characteristics had been thoroughly established. Low aspect ratio wings were known to have greater stalling angle than the high aspect ratio wings necessary for good climb, so he instructed Miles, the model-maker, to cut five narrow chordwise strips from the little wooden wing to form six conjoined winglets in

expectation that 'live' air from the underside would flow through the slots to the 'dead' air at the top. Tried in the wind-tunnel it gave disappointing results, for the modified version had lower lift than RAF 15 and greater drag, but slightly delayed the stall. Turning again to the bird's wing and its emarginated fingered tips as a shape specifically evolved to give maximum sustentation, H.P. took another standard wind-tunnel wing and told the model-maker to fashion five roughly representative pinion feathers about four inches long at each wing-tip. They were not even varnished.

Four years later, as a student in the Handley Page aerodynamic department, I saw both these models and subsequently from Geoffrey Hill, brother of Roderic, heard an account of those early experiments. Using smoke candle tests to reveal the air flow, H.P.'s observant eye had detected that, at the stall, separation occurred near the leading edge. The pinion tip had indicated the potential of lateral instead of chordwise slotting, using a backward sloping aperture. From that it was a logical step to try a full-span aperture. Wind-tunnel tests revealed substantial lift increase, with the stall delayed to much greater angle, though the drag was greatly increased. It was tremendously exciting. Here was a breakthrough which might give Handley Page aircraft immeasurable superiority. 'We must secure world-wide patents,' said the delighted pioneer. Meanwhile another model of the Airscrew 64 section he had adopted for the W.8 was prepared to study the effect of a venturi section slot. There was further increase of lift. Multi-slots revealed that stalling could be delayed to the astounding incidence of 45 degrees. Experiment was now directed towards different shapes and different openings of more practicable arrangements. The simple wind-tunnel adjustable link used for this purpose gave the clue to mechanically shutting the slot gap for high-speed flight to restore the normal ratio of L/D. Until the patent was granted, here was an invention of top secrecy. It was not even to be built into the new W.8 lest the workmen talked about it. Certainly the application might have been argued invalid had Oswald Short recollected that in 1910 he and his brothers were granted Patent No. 2613 in which laterally disposed slats were pivoted leading edge downward so that they could be used as variable-lift controls. Nobody knew that in Germany a student pilot, Gustav V. Lachmann, had applied to patent a wing divided into a number of part aerofoils separated by nozzle-shaped lateral slots.

Robert Blackburn – H.P.'s contemporary as a pioneer – was also interested in methods of finding superior aerodynamic performance. He was in process of removing his aeroplane resources from his Olympia works in Leeds, which was earmarked for manufacture of motor-cars and other diversifications, to his seaplane station at Brough because of the convenience of its adjacent aerodrome. At Harris Booth's instigation he had become interested in the inventions of A. A. Holle, who before the war had formed the Varioplane Co Ltd, which was backed by H. J. Mulliner Ltd, the famous coachbuilders. As a follow up of the variable-camber system he patented in 1916, Holle had developed in the summer of

1918 a twisted cantilever wing characterized by a tip rake so extreme that it was really a heavily tapered wing with straight trailing edge, though he also patented the reverse form. Failing to interest the Technical Department of the Air Board, he sent a model to France for test in the Eiffel wind-tunnel – where a resistance far lower than any conventional wing was recorded. Lateral control was secured by a patented method of mounting a portion of the leading edge on a cantilever steel spring so that it could be flexed either up or down, and by variation of this system he secured an additional patent for ailerons recessed into the leading edge 'which preserved the shape of the aerofoil when closed, but are capable of upward movement by pivoting about a pin in the leading edge'. He had nearly stumbled on the same device as Handley Page.

Hopefully, Robert Blackburn registered the Commercial Aeroplane Wing Syndicate Ltd as a private company with capital of £30,000 'to take over from A. A. Holle of 19 Half Moon Street, Piccadilly, gentleman, an invention for improvements in aerofoils for aeroplanes and the like'. The subscribers, each with £1 share, were the inventor and his accountant A. G. Morrish, but the Blackburn Aeroplane and Motor Company was entitled to appoint two directors, and the secretary was A. S. Wigglesworth of Blackburns who now nominated Harris Booth as Technical Director of the new company. It led to design of a highly streamlined freighter aircraft with engines contained within the monocoque fuselage, driving outboard propellers behind the highly sophisticated cantilever wing, but nobody would venture an order.

6

Newspapers, prompted by the Government, began preaching to the public that the only solution to the economic situation was for everyone to work far harder than ever before in order to make up for the wealth which had been blown away in bombs and ammunition instead of making articles which could be exported. Propaganda did little good. There were still industrial disputes, with the miners at the core of the trouble determined whatever happened to press for greater pay and shorter hours. Coal production, on which reliance was placed as our chief export, was disastrously low. Towards the end of September the railwaymen went on strike. There were urgent requests for volunteer service for food supplies, communications, and for a great milk depot in Hyde Park. At the beginning of October the strike was disrupting everything. J. H. Thomas, the railwaymen's leader, listed to the Press some of the causative anomalies, instancing railway shunters who got only 60s a week whereas a colliery shunter got 70s to 75s a week; a railway guard with years of service similarly was paid 60s a week, but a bus conductor after six months could have 73s. Above all, the railwaymen were dissatisfied with the Government's promises of pay settlement by mutual agreement, particularly as war bonuses would be cancelled at the end of the year.

The strike provided a golden opportunity for civil aviation to show its

worth in carrying mails and people on urgent business. A. V. Roe had every available Avro taking newsprint and mails; B.A.T. was operating a service from London to Birmingham; Nieuport and General Aircraft had their new two-seat Nighthawk carrying mails to Dublin and Edinburgh; Supermarine were busy with cross-Channel flights between Woolston and Le Havre, and Solent flights to Bembridge in the Isle of Wight; Vickers were commuting between London and their naval construction works at Barrow; Airco, Handley Page Transport, Grahame-White Aviation, and Blackburn's North Sea Company were all fully engaged on emergency flights. Even the Royal Air Force was lending a hand with newspaper deliveries, and augmented their official service between London and Paris. Yet despite these facilities people preferred to stay at home. That there was so little demand for Continental flights was even more discouraging – also surprising, for civil aviation was statistically a reasonably safe means of communication, as instanced by the Avro company which in the last few months had carried 30,000 passengers without a fatal accident.

In gay blue and silver check, the two-seat Nieuport Nieuhawk was built from single-seat fighter components and tested by Capt L. R. Tait-Cox in the summer of 1919, and then prepared for demonstration in India to which it was freighted at the end of the year. (*Flight Photo.*)

Amidst all the confusion of disrupted transport, preparations for the great Jacques Schneider Trophy contest at Bournemouth were continuing apace. France had entered a racing Nieuport and a Spad, with reserves, and Italy a Savoia flying-boat; but they had a formidable opposing team in the contestants from Great Britain, where entries from Sopwith, Supermarine, Avro, and Fairey had been confirmed and would necessitate trials to select the best three. The squat little Sopwith with its powerful 450 hp Jupiter was exceptional in having a power-loading of under 5 lb/hp, so was regarded as the likely winner. Roy Fedden, despite disasters overtaking the Cosmos company, had already achieved remarkable reliability with his new engine, though it weighed only 636 lb. However, both the Nieuport

The post-war Sopwith Schneider was a stubby, robust-looking seaplane, very much Harry Hawker's idea of a cheaply made racer. Floats were not hydrodynamically good, but represented the nearest possible approach to an aerodynamically streamlined section. (*Courtesy C. H. Barnes.*)

and the Spad were remarkably clean, and like the Sopwith were credited with more than 160 mph. The Fairey, with its 450 hp Napier Lion was regarded as a splendid second choice if weather was rough, for the Sopwith had negligible reserve buoyancy whereas the Fairey was of proved seaworthiness. The choice between the powerful Supermarine flying-boat and the Avro with the 240 hp Puma was in doubt until the very day of the race, when the Supermarine was given a new airscrew and gained a good 5 knots, but it led to much heart burning when the Avro was eliminated.

The Puma-powered Avro 539 Schneider seaplane of $25\frac{1}{2}$ ft span was initially tested on 29 August, 1919, by Capt H. A. Hamersley, but directional instability necessitated a much longer fin with appropriate increase in rudder size as shown. (*Flight Photo.*)

Here is the metamorphosis of Fairey's N.10 seaplane to civil guise as a Napier Lion powered Schneider racer with short span single-bay wings replacing the original twin bay of 46 ft span. It is shown on the slipway at Hamble Spit. (*Fairey Aviation.*)

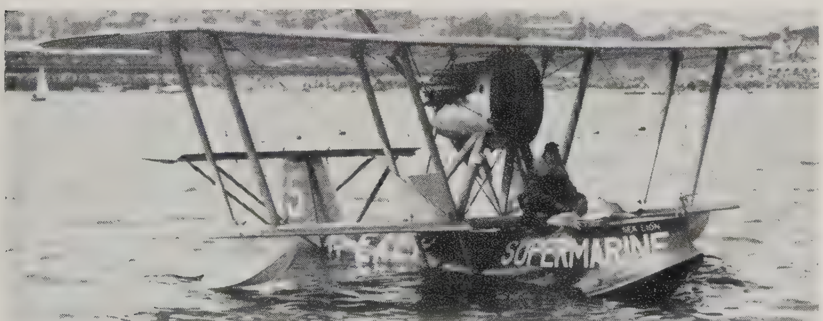
Unfortunately the French team had very bad luck. The second Nieuport flown by M. Malard was lost in mid-Channel, though the pilot was eventually rescued. Lieut Casale flying the first of these beautifully streamlined racers, which M. Chasseraux had designed under the direction of M. Delage, left Paris the Sunday before the race and arrived at Cowes via Brighton in $2\frac{1}{2}$ hours, but in descending hit the top of a buoy and swept off his floats and undercarriage, and the machine sank. The generous Sam Saunders quickly salvaged it, and under the care of his works manager, George Newman, his men laboured non-stop until Wednesday morning in order to rebuild the machine, working 'in defiance of all modern labour notions for practically 48 hours at a stretch, and demonstrating conclusively that, whatever the British workman may be, he is at heart a sportsman'. That afternoon Casale flew the Nieuport to Bournemouth, but despite the gentlest of alightings on the calm water she began to sink, and on beaching her it was found that a float had cracked.

The extremely advanced-looking Spad, which young M. Herbemont had designed with stumpy monocoque fuselage and **I**-struts, had been put out of the race only a few moments before because the Royal Aero Club had not thought it worth laying moorings for competitors, and when Sadi Lecointe attempted to beach the Spad, the rough stones cut a hole in her floats. With amazing irresponsibility the Royal Aero Club had assumed no special arrangements were required to safeguard these expensive racers, and that the pilots would automatically understand they had to beach their machines on arrival – with the result that after alighting, all competitors at first taxied around wondering what to do until helped by a funny little motor-boat called *Tiddlywinks* provided by Supermarines, which was

basically the hull Pemberton Billing had made just before the war for his detachable-wing flying-boat. The British teams cheerfully set to and erected fences around their chosen beaching spots, but when the foreign pilots came ashore they found nobody to hold off the mob nor even to interpret. But for the undefeatable Newman, who found food for the French and Italian teams, established a guard, and made temporary launching slips, they would have been quite ignored among the milling crowd. Meanwhile the Royal Aero Club officials were happily established in what one cynic described as 'an epicurean epithalamium' aboard the TSY *Ombra* which had been borrowed from Grahame-White's brother Montague for the occasion.

The race was due to start at 2.30, but by then fog had begun to roll in from the sea and visibility dropped to 400 yards. At tea-time the fog had passed inland, leaving a heat haze through which the Needles of the Isle of Wight could just be discerned. Without further investigation the Committee decided to start the race. First away was the Fairey piloted by Colonel Nicholl, but on reaching Swanage Bay found it full of fog, the mark boat hidden, and only the top of the cliffs revealed. Returning to Bournemouth he reported to the tall and statuesque Dick Fairey that conditions were not good enough, and they withdrew their seaplane from the race.

Next Sqn-Cdr Hobbs took off the formidable-looking Supermarine Sea Lion in a cascade of spray. Said an onlooker: 'All that was seen of her was what looked like a circuit of the course. She came down at the end of the first lap to do the two alightings specified by the rules, and at the first attempt changed at once from a Supermarine to a submarine.' The flat calm and poor visibility were her undoing. Finding he could see no marker at Swanage, Hobbs alighted to see if he could locate it from the surface, and failing to do so took off for Bournemouth, but just as he was leaving the water felt the boat hit something with a crash. As he was airborne, Hobbs continued on what he hoped was the race circuit, and then landed as near as possible to a Naval coastal motor launch – only to go



Conversion of a fighter flying-boat to international racer – the Supermarine Sea Lion I about to have its engine started by the Napier mechanic. Sqn-Cdr B. D. Hobbs is squatting on the hull. Span was 35 ft and maximum speed 147 mph.

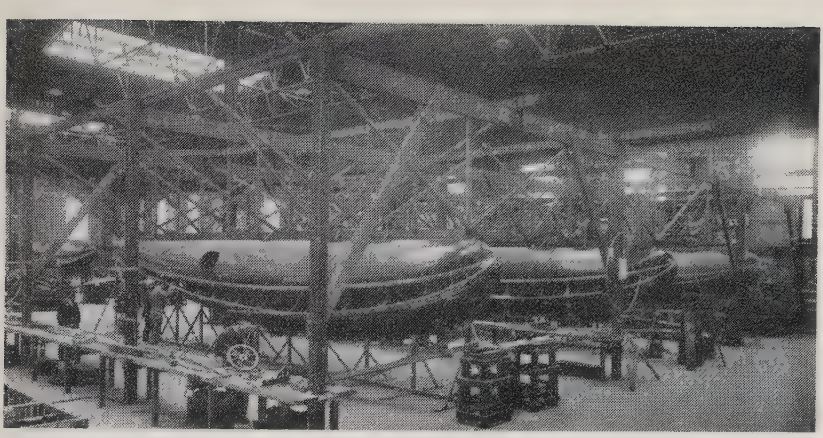
straight under because the bottom of the Supermarine had been holed at Swanage. A few seconds later he was rescued by *Tiddlywinks*.

Next away was what many thought the least likely winner – the dimensionally similar but far less powerful Savoia, piloted by a fair-haired, blue-eyed, non-commissioned youngster, Warrant Officer Janello of the Italian Navy. After considerable indecision as to whether he was being officially started or not, he took off towards Poole, returned to make the two mandatory landings, then began lap after misty lap around what he assumed was the triangular race-course. Somewhere about the ninth lap Tom Sopwith, who had been stop-watching the circuits, perceived that the times were much faster than seemed possible for the Savoia. There were doubts in the Italian camp too, for when Janello alighted after completing one more than the statutory 10 laps as an attempt on the seaplane speed record, his time had been so fast that Signore Santoni, the founder of the Savoia company, went in a motor-boat to ask him to fly a twelfth lap in order to be certain that he had covered the full course.

Meanwhile Harry Hawker took off with the Sopwith, and streaked away for Swanage. In very short time he returned because he was unable to find the mark boat. Alighting close to the Bournemouth beach, the machine began to heel over to the right. To save it he opened the engine wide and shot on to the sand, ruining his floats.

The Savoia had been expected back from its check speed lap in 10 minutes; but 20 passed, 30, and then 40 with no sign. The Christchurch mark boat returned, and reported that Janello appeared to have passed it ten times but certainly not eleven or twelve. Officials seemed quite oblivious that the Italian was down somewhere at sea and might have crashed. The Royal Aero Club committee members were being landed from the *Ombra* at Bournemouth pier and Grahame-White's motor-boat sailed off for Cowes to avoid being trapped by the fog. No search boat of any kind was available until once again the redoubtable Newman came along with a Saunders' launch, took Janello's colleagues aboard, and proceeded to HMS *Malaya* lying a little way off, and requested help. While the cruiser was securing consent from her Flagship they caught sight, in the fading water reflection of the westering sun, a slow motor-boat towing a flying-boat. The Savoia was safe! The Saunders' boat raced up, and towed her to Bournemouth beach, then sped back to Cowes at 16 knots with the Italians aboard. There they learned that the Swanage mark boat had never actually seen Janello at all, and he was asked to indicate on the chart of Studland Bay where he had seen the mark boat – but pointed far from the correct location. The Royal Aero Club declared the race null and void, though undertook to move a motion at the October meeting of the Fédération Aéronautique Internationale that the Schneider Trophy for 1919 should be awarded to Italy on grounds that Janello flew the full distance specified by the rules, and that any error in the course was due to a British mistake.

There were repercussions by way of protest from Italy and France, and



The Lytham hull building shops of the English Electric owned Phoenix Dynamo Company, showing three P.5 hulls in the stocks and an M.4 hull in the background. Bottom and chines were built on to the basic boat-timbered shell as a separate structure.

letters to the British Press explaining away the fiasco. Criticism by *The Times* of seaplane behaviour, whether in calm weather necessitating high take-off speed or a fresh breeze with choppy waves which could damage the floats, drew a vigorous reply from Dick Fairey who sensibly pointed out that the failure had been entirely due to the impossibility of seeing the mark boat; but he made splendid publicity of the seaworthiness of his machine, which he stressed had been delivered to the Government in July 1917, was repurchased by him in March 1919, and during this period made several hundred landings in all weathers using the same floats. Said he: 'I would state that at a time when the seaplane by its superior lifting capacity, its lower depreciation, its independence of prepared aerodromes and its immensely greater safety, appears in the eyes of many experts to be the only form of aircraft having an immediate commercial future, it is unfortunate that the British Seaplane Industry should be the subject of such ignorant criticism, particularly in the pages of so responsible a journal as *The Times*.' He contended that seaplanes had advanced to far greater extent than landplanes and that Shorts' wing-folding gear, the Fairey variable-camber wing, Linton Hope's flexible hull, and Major Cooper's servo motor control relay were such great advances in seaplane design that only in America, with introduction of the retractable chassis, had comparable advance been made for aeroplanes.

7

From seaplane racing and its uncertainties, aeronautical interest turned to an official communiqué issued from the Air Ministry on 19 September:

'The flight for a prize of £10,000, which was offered by the Australian Government in March last, was the subject of a conference to-day between representatives of the Air Ministry, Australian Commonwealth, Royal Aero Club, and competitors.

'It has always been recognized in official quarters that a flight between England and Australia would be a performance of great difficulty in the present state of lack of ground organization, and that considerable time must elapse before the project could mature. Since little information was available on the proposed route beyond Calcutta, it was decided that no competitor should be allowed to start until the Air Ministry has been able to obtain reliable data concerning the section between Calcutta and Port Darwin.

'Brig-Gen A. E. Borton, DSO, and Capt Ross Smith, of the Australian Flying Corps, were accordingly despatched to carry out a special survey and report on the possibility of a flight being successfully attempted. These two officers have now returned to England and to-day furnished detail information, reporting that beyond Calcutta the route lies over country far from favourable for aeroplane flying. Between Calcutta and the Dutch East Indies the only landing grounds suitable for immediate use are the Race Courses at Rangoon and at Singapore. Beyond Singapore, where the route lies over the Dutch islands, the next place where good landing facilities exist is Bandoeng, and thence no landing ground is available for the intervening 1,760 miles to Port Darwin. As the weather after the end of November is most unfavourable, General Borton expressed the view that if the flight is to be made this year only aeroplanes possessing a range of at least 2,000 miles could make the attempt with any hope of success.'

Here was the next challenge to the industry. Vickers had earmarked a Vimy and lost no time in offering Ross Smith the job of flying it in view of his successful survey of the route. Martinsyde and Sopwith Aviation were already building machines based on their respective transatlantic contenders. Tom Sopwith regarded such contests purely as propaganda methods of educating the non-flying public to the possibilities of aerial transport, and took a pessimistic view of the immediate future. 'So far as the policy of my Company is concerned we propose actively to engage on experimental and competition work, but I think that, for the next several

Sir John Alcock in his Crossley seen beside the Vimy entered by Vickers for the Australian flight. The aircraft is now on permanent exhibition at Adelaide.

With crew enclosure for cruising and lifting seat for take-off and landing, the Sopwith Wallaby derived from the Cuckoo and Atlantic had the same span of 46½ ft. After crash-landing in Bali it was rebuilt in Australia as an eight-seater. (*Sopwith Aviation.*)

months, it is only reasonable to regard the civil aviation side of any aircraft business as a state of semi-suspended animation. However, it is of vital importance that the chief designing firms should maintain at any rate a nucleus of their aviation staff and factory personnel, so that the *métier* may not be lost and the industry become moribund. In the meantime it is only possible to do this by taking up manufacture of products outside aviation, and of such nature as to keep as far as possible the *status quo* as an aviation firm. As to the military side, this remains wrapped in mystery. It is therefore impossible to estimate what prospects there will be of aviation firms having Government support. Nevertheless I am sure that aviation has a future, be it soon or late, but the only way to ensure its security is to hasten slowly.'

Meanwhile share values of every company were dropping. Airco's had gone from 27s to 15s. The directors of Sir W. G. Armstrong Whitworth & Co frankly admitted that the result of their enquiries as to the possibility of business, whether in England or abroad, did not justify continuance of aircraft manufacture for some years to come. Nevertheless a few business houses were contemplating use of communication aircraft, and the firm of S. Instone & Co Ltd, steamship owners, led the way with the purchase of a 375 hp Eagle-powered D.H.4, and engaged Lieut F. L. Barnard to fly it. Only the engine firms seemed convinced that their new products would be required. Of these Roy Fedden was desperately trying to sell the Cosmos company either to Vickers or British and Colonial – but only John Siddeley was actively interested in hope of buying out a rival to his own products.

Depression did nothing to deter candidates for the Australian flight. The Sopwith Wallaby, a wide-span three-bay biplane with enclosed cabin for pilot and navigator, caused surprise at its early completion when seen towards the beginning of October under test at Brooklands in the hands of Harry Hawker. There was added surprise when it was announced that instead of Harry Hawker – who was allocated to demonstrate a Sopwith in

Portugal – 36-year-old Capt George Matthews and Sgt Tom Kay, both of the Australian Flying Corps, had been selected as pilot and engineer. Powered by the well-proved 375 hp Eagle VIII, the Wallaby achieved a maximum speed of 121 mph, enabling cruising at 107 mph at 5,000 ft with a range of 1,500 miles, and a ratio of useful load to total weight of 46·5 per cent. Because the number of reception stations *en route* was limited no radio was fitted.

On 21 October they left Hounslow shortly before mid-day. Nothing further was heard until 24 October when the Air Ministry stated that the Wallaby had landed at Cologne at 2 pm on 22 October.

In the interim – while people were speculating on the possible fate of the missing Australian airmen – British aviation suffered great loss by the death of Colonel John Cyril Porte, CMG, on Wednesday 22 October after years of suffering from tuberculosis. Despite litigations and innuendos of graft, he had performed great service in developing the original Curtiss *America* flying-boat into a vital and effective war-time tool for the Royal Navy. John Porte had remained in command at Felixstowe until well after the end of the war, and had not long resigned from the RAF in order to devote his time to development of still bigger flying-boats which would be built by the Gosport Aviation Co Ltd. As one of his friends wrote: 'Everything seemed to point to a great success which would recompense in some measure for his treatment by the Government. He had collected around him a staff of flying-boat specialists whose value he had proved at Felixstowe, and had secured adequate financial support. It is to be hoped that those with whom he was working, and who have his plans in hand, will be enabled to carry them through for the future good of this country and as a memorial to the great man who originated them.' But without John Porte the driving spirit was lost. It spelled the end of the Gosport company. Throughout all the history of aviation it was the initiator, the zealot, the man of burning vocation who alone could achieve the goal that only his vision saw: there was rarely a stand-in until later days of big management teams who were imbued with a different dynamism.

That other devotee of big aircraft, Frederick Handley Page, after many urgent telegrams, had at last managed to get the V/1500 he had originally sent to Newfoundland for the transatlantic flight started on a demonstration tour of the USA, piloted by Major Brackley – but in a 12-hour flight it unfortunately failed to achieve New York, landing 95 miles away owing to shortage of petrol. However, Admiral Kerr, still in charge of the operation, with great aplomb told the American Press that the 'super giant' had achieved a world record by carrying 11 passengers during this non-stop flight.

Another of Handley Page's interests was also encountering difficulty. Criticism of the conservative attitude of the Royal Aeronautical Society had led to the formation of a rival body, the Institute of Aeronautical Engineers, whose aim was to bring aeronautical discussions to more practical level than the theorists of the society preferred. R. L. Howard

From Newfoundland the impressive Handley Page V/1500, originally intended for the transatlantic attempt, was flown to New York on a sales promotional campaign. It failed to sell, but led Handley Page to believe his subsidiary company in the USA ought eventually to become an asset. (*S. T. A. Richards.*)

Flanders, employed at this time on minor tasks by the Cosmos Engineering Co, was elected President. Established designers such as Henry Folland and Roy Chadwick were quick to join. But it appeared the primary intention was that the Institute should act as a trade union 'to ensure that pilots and designers were adequately remunerated, and that they received a suitable share of prize money won in public competition. The union would keep a record of the abilities of its members so that vacant posts would be filled by men with the requisite knowledge and experience.' It was also proposed to hold examinations for qualification to the several grades of membership carrying the right to use designatory letters such as MIAeE. Under the lash of Handley Page the RAeS began to consider how its own position could be improved.

Aeronautical education was coming into its own. Capt B. Melvill Jones, known as 'Bones', had been appointed first Mond Professor of Aeronautics at Cambridge, assisted by Capt Farren, lately in charge of Farnborough aircraft design. They were building a 28 inch wind-tunnel for their research laboratory. At East London College, Dr Piercy was re-establishing the course initiated before the war by Dr Thurston. Similarly, Dr Mullineaux Walmsley of the Northampton Institute had revived aeronautical engineering among its mechanical and civil engineering courses, and the department had been placed under the charge of Sqdn-Leader F. W. Bramwell for full-time day courses in addition to the evening classes over which Frederick Handley Page had presided in pre-war days. The laboratory had little equipment, and the syllabus brochure warned: 'It cannot be too strongly impressed upon would-be students of aeronautical engineering that it is hopeless to attempt to acquire any useful knowledge of a specialized application of engineering, such as aeroplane design, without first acquiring general knowledge of engineering principles, and a sufficient knowledge of mathematics to carry out calculations involved in an application.' There

were no grants for students. Parents paid for those who entered straight from school. Ex-service men subsisted on their relatively small war gratuity. For all their camaraderie they were serious men intent on attaining professional status as quickly as possible, and they proved an inspiration to the post-war younger students who would be competing with them in the engineering world.

Where pioneer designers had groped for theory, there were now books of considerable authority on the design of aircraft. A. J. Pippard, MSc, having left the Air Ministry, substantiated his great work there on the strength of aircraft by compiling with his former assistant, Capt J. L. Pritchard, BA, a book entitled *Aeroplane Structures* which gave a thorough grounding on the art of stressing at a cost of 25s net. It was followed by a splendid book entitled *Applied Aerodynamics* written by Dr Leonard Bairstow who until recently had been responsible for aerodynamic research at the Air Board, and now was proposed as Zaharoff Professor of Aerodynamics at Imperial College, London. His book quickly became the classic of contemporary aerodynamic theory embracing the vast field of research undertaken by the NPL and RAE. For the aeronautical draughtsman A. W. Judge compiled what was known as a 'Super-Molesworth' of 1,040 thin and narrow pages with 350 tables devoted to every possible aspect of D.O. technical data, structural and aerodynamic statistics, calculation of performance, stability and control, and aero-engine and pro-

Grahame-White's E.IV Ganymede bomber tipped on to its nose after a forced landing but was not too greatly damaged for rebuild as an airliner, though without the pusher engine. (*Courtesy C. H. Barnes.*)

Cumbersome in appearance with its twin fuselages and new big central passenger cabin, the civil E.IX conversion of the Grahame-White Ganymede, powered by two 450 hp Napier Lions, was built more in hope of keeping the factory running than as a viable aircraft. (*D. Napier & Son.*)

peller design. At 30s it was a complete guide to the art, though a little out of date in places.

Unfortunately it was becoming more and more doubtful whether the aircraft industry could accept further entries. Certainly the doors seemed closed to the ambitious young. With the recession of summer there was growing pessimism. Typical was the current *Flight* report from Hendon: 'Very little has been heard of the London aerodrome at Hendon since the last of their summer meetings fizzled out owing to lack of public interest some months ago. With the general slackening down of the aircraft industry since the end of the war, it might have been thought that the place had died a slow and lingering death, but when one does get inside, quite a respectable amount of activity is to be found. On the afternoon of October 17th one's guide was Major Carr, AFC, DCM, that famous pre-war Grahame-White pilot, and under his guidance we toured the workshops where a few aeroplanes are still being constructed. The most worthy of note was the Ganymede and two Grahame-White Limousines. The Ganymede was constructed as a long-range twin-fuselage three-engined bomber but was not accepted by the Air Ministry. The pusher engine has been removed and replaced with a large long cabin with seats for 18, and two Napier Lion engines have now been fitted in each side fuselage. The machine has accomplished some quite successful test flights. One of the two Limousines was recently on test when the engines cut out owing to failure of the fuel system. Unfortunately the landing had to be made on a rough allotment and the machine was somewhat damaged, though would have fared much worse except for the two sturdy emergency landing-wheels at the bottom of the fore-end of the cabin.'

No operator showed much interest either in the Ganymede or Limousine. There was no market for new aircraft. Nevertheless the Caproni company of Italy were making vigorous attempts to enter what they hoped was a British prospect for their triplane which had twin tractor-powered fuselages like the Ganymede and a two-storied passenger cabin amidships with a pusher engine. One of these monstrosities was displayed at Hendon; its next destination was Sweden.

Built by the Alliance Aeroplane Co Ltd to the design of J. A. Peters late of Ruffy, Arnell and Baumann Aviation, subsequently incorporated with Alliance, *Seabird* had been a hopeful entrant for the transatlantic flight despite the bad view from the cabin. (*Courtesy C. H. Barnes.*)

Meanwhile further entries were being received for the immense flight to Australia. The second prototype Alliance, replacing the transatlantic machine which had crashed, was entered to be flown by Lieut Roger Douglas and Lieut James Ross, and at the end of October was ready. Vickers now formally entered their Vimy piloted by Capt Ross Smith, MC, DFC, AFC, who would be accompanied by his brother Lieut Keith Macpherson Smith, and they would have Sgt J. W. Bennett, AFM, MSM, and Sgt W. H. Shiers, AFM, as engineers.

Robert Blackburn then entered a Kangaroo under command of the explorer Capt G. Hubert Wilkins, MC, who would have Lieut Val Rendle and Lieut D. R. Williams, both Australians, as pilots: Rolls-Royce had supplied two specially tuned 275 hp Falcon engines for this attempt. Meanwhile Capt Matthews with the Sopwith Wallaby was still held up by bad weather at Cologne. His Brooklands rival, the Martinsyde, was being prepared for an attempt in the hands of Capt C. E. Howell, DSO, MC, DFC, who knew the Far East well, and relied on the clean little biplane of 43 ft span being the fastest entrant as the top speed was 130 mph, yet with ability to land slowly owing to light wing loading. No attempt was made to give him and his mechanic the protection of a cabin, and what spare room there was stored a spare propeller. From Calcutta onwards it was expected to use the machine as a seaplane.

8

While England was groping to establish aircraft services, defeated Germany was proceeding unfettered with new Zeppelins. The first of these, the *Bodensee*, based on Berlin, in her initial month of operations carried 1,300 passengers in 30 voyages aggregating more than 200 hours, but at the beginning of November she got out of control when attempting to land at Staaken in a gusty wind, and only after an adventurous night was she cushioned down on fir trees 100 miles away. Undoubtedly the airship pundits in Great Britain fully realized the difficulties of such airship operation, but they had staked their careers on the possibility of Empire

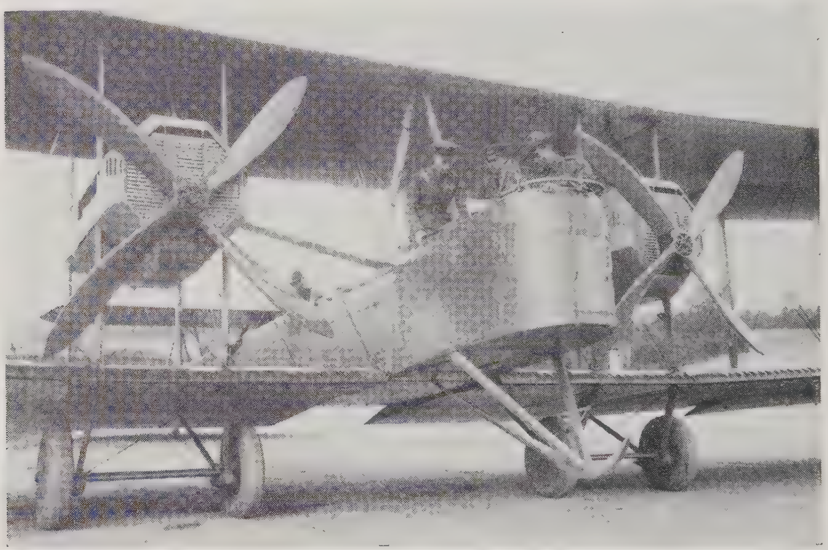
route transport by this means, and in hope that British rigids might be reprieved were making the most of the marginal achievement of the R.34 in crossing the Atlantic twice.

Armistice Day on 11 November introduced memorial church services all over the country – but by now the days of war seemed so far distant that they were almost unreal. So it was with interest that people turned to several war books published that autumn in order to discover what had been behind the successes and defeats. First was General French's sensational *1914* in which he admitted authorship of the newspaper campaign of 1915 intended to discredit Lord Kitchener over the supply of shells. Soon the book was followed by memoirs of Lord Fisher and then of Lord Jellicoe, and it became clear that differences of opinion created during the war were still on the rampage. Soon Germany's leaders followed with their accounts, but these seemed to blame the German civilian population rather than the generals for their country's disastrous collapse.

More significant was the launching of the League of Nations Union at a great meeting in London at the instigation of Lord Robert Cecil. His intention was to keep the objectives of the League constantly in the public mind, and particularly that it was a means by which nations could avoid wars by joint co-operation. Yet the public was only idealistically interested. Imagination was caught much more by the story of a German professor called Einstein who had evolved a new theory of transmission of light, and had just completed mathematical verification which he had been calculating ever since an eclipse of the sun at the end of May. It intrigued the populace that the fundamentals they had been taught at school whereby the shortest distance between two points must be a straight line was apparently not true, and that Newton had been mistaken about his falling apple. Yet to mathematicians and scientists here was a valid theory affecting the whole conception of the universe.

On 12 November Maj-Gen J. E. B. Seely announced resignation of his appointment as Under-Secretary of State for Air, reminding Parliament that the Prime Minister had asked him to go to the Air Ministry 'to preside over the Council', but he found it a curious arrangement because Winston Churchill held the Seals as Secretary of State both for War and Air, and by anomaly the Admiralty was left out. 'Nevertheless, I undertook the duty gladly, and endeavoured to work it, but it very soon became apparent that the thing would not work, not for any personal reason, but because by actual fact and by Statute the only man who can preside over the Council is the Secretary of State. As soon as this became apparent I informed the Leader of the House that the arrangement was bound to be inefficient and wasteful and that I would ask for a change. When the Prime Minister returned on 1st July I put the case before him, but the decision was delayed until twelve days ago when he begged me to reconsider my position, but told me that he had decided on the present plan after due consideration and did not propose to abandon it. The only possible course, whoever of us was right, was for me to resign.'

That same day the Vickers Vimy left Hounslow at 9.10 a.m. on the first stage of the tremendous Australian flight. The Alliance chased after it 24 hours later, passing low over South Teddington, and appeared in difficulties. At Surbiton it suddenly dived to the ground, hitting a tree, was totally smashed, and the two pilots killed.



The crew of the England–Australia Vickers Vimy opened a great Empire route. Standing in the pilot's cockpit is Capt Ross Smith with his brother Lieut Keith Smith. Sgt J. M. Bennett is alongside on a foothold and Sgt W. H. Shiers is in the rear cockpit. (*Vickers Ltd.*)

This sad drama was followed by news that the Vimy had reached Lyons the previous day after a flight of $6\frac{1}{2}$ hours and immediately proceeded to Pisa. On 18 November it was learned that the machine had arrived at Rome after experiencing very bad weather. A cable sent to Acland by Ross Smith vividly indicated the nature of their difficulties: 'Yesterday at Pisa heavy rain – aerodrome under water – attempted start – got bogged – spent day on machine – had engines running eight today – bogged badly taxying – used planks – Italian mechanics dug out machine – bogged again – finally got away – sensational start – Bennett held tail down until machine moving then made running jump at rear cockpit – hauled aboard by Shiers as machine was leaving ground – aerodrome two inches under water but Vimy rose beautifully – crew very wet but cheerful – encountered strong head wind – ground speed only 50 mph – passed through some heavy clouds otherwise hazy bumpy but landed Rome 3 o'clock.' By the time this telegram was received on the 18th the machine had reached Cairo, and on the 19th was at Damascus.

From Cairo Ross Smith had cabled: 'Left Suda Bay eight today – arrived Cairo 3.30 – weather again bad – low clouds made crossing Crete mountains

difficult – winds slightly favourable – steered south after leaving, but had to fly through rain at 2000 feet most way across Mediterranean – passed two steamers half-way, checked ground speed and drift on them – crossing took $2\frac{1}{2}$ hours – struck African coast Sollum, then flew east to Cairo across desert via Matruh and Wadinatrun – hope Damascus or Bagdad tomorrow – all very pleased to have got here – hope for better weather now – so far have taken 30 flying hours mostly through rain and storms – throughout greatest assistance rendered by aerial route stations – nothing being too much trouble – largely due their excellent organization we here so soon. Vimy going perfectly.' On 25 November they reached Delhi, and were at Allahabad on the 27th, leaving for Calcutta at 8.30 next morning. Given a little luck it looked as though they would easily be the winners, but the Blackburn Kangaroo which had left Hounslow on 21 November was going to tail them, and reached St Raphaël at 4 pm on 28 November, departing for Capua next day.

Concurrently there appeared in *The Times* a letter from Admiral Lord Fisher: 'Sir – by land and sea the approaching prodigious aircraft development knocks out the present Fleet, makes invasion practicable, cancels our country being an island, and transforms the atmosphere into the battle ground of the future. The air controls the water. Unless all warships can get under the water they will be blown out of the water. Millions upon millions of money is still being wantonly wasted in the upkeep of ships that can't be used in war. – Yours Fisher.'

Thus spake the prophet who once had controlled the destinies of the Navy and of England.

Towards the end of November HM Stationery Office issued a White Paper reviewing progress of civil aviation during the initial six months from 1 May to 31 October, 1919. It reported that the International Air Convention, based on the British Air Navigation Regulations, was signed on 14 October by 11 out of 13 Nations as the USA and Japan were not yet in a position to sign.

The Paper stated that the Cairo–Karachi route had been opened for military purposes, and would be available for civil traffic at early date; similarly, the route from Cairo to the Cape had been surveyed and a chain of landing places established.

In six months some 4,000 hours had been flown and 52,000 passengers carried at an injury risk of one in 5,000, though there had also been two fatal accidents to pilots. Already 374 pilots and 258 ground engineers had been licensed. There was surprise that the number of pilots was no greater – as was quickly pointed out by *The Aeroplane*: 'There must have been nearly as many civil pilots before the war, seeing that 863 aviator's certificates had been issued up to August 4th 1914, in this country alone. It is true that many were Service people and that others rarely flew after qualifying for their certificates, but there certainly seemed much more flying before the war than there has been all this year.' Nor was it any index of manufacturing optimism but only of exploitation of the novelty

attraction of joy-riding that 241 aircraft had received certificates of airworthiness, and 92 aerodromes licensed for civil purposes. Nevertheless, 10 major cities from Edinburgh to Southampton were negotiating establishment of aerodromes under control of their municipal authority.

It was a sign of the times that many aircraft firms were building car bodies, motor-cars, or motor-cycles and side-cars. Armstrong Siddeley were pinning their faith on an impressive saloon double-phaeton, with 29·5 hp six-cylinder engine, sold at £1,000. The Standard Motor Co Ltd had dropped aircraft and was tackling medium-priced open tourers. A. V. Roe were attempting production of a car, and experimenting with small runabouts, but it was clear to Alliott Roe and his directors that the financial position was becoming critical. Through war-time sub-contracting, A.V. had met Sir Kenneth Crossley, and negotiations were presently concluded for a combine in which Avro shares were exchanged for Crossley shares, and the motor-manufacturing company then placed large orders with A. V. Roe for car bodies. At that time Crossley shares stood at 34s. Meanwhile John Lord, as managing director of the Avro works at Manchester, was steadily discharging factory workers, for the prospect of a production line of the Avro Baby and cabin versions of the 504 was so small that it could be entirely handled by the Hamble factory where A.V. was determined to continue experimental work at all costs.

Converted from a Bentley B.R.1 powered Avro 536 open five-seater, the 546 had a seaplane fin and cabin enclosure with openable top and four Triplex windows beneath the top longerons. The three passenger seats were lowered to give head room. (*A. V. Roe.*)

Even Sopwith had turned to manufacture of the A.B.C. motor-cycles designed by Granville Bradshaw. An application was made to Mr Justice Astbury in the Chancery Division on 2 December for sanction to alter the objects of the company in order to enable them to make all kinds of furniture, and other goods such as motor vehicles. Similarly, Martinsyde were in production with a splendid vee twin Martinsyde-Newman motor-cycle combination of which deliveries were planned to commence in January at a price of £170.

On 19 December the first post-war Paris Aeronautical Exposition would open. Here was the next big target. All manufacturers were preparing their exhibits – of which Handley Page was about to spring a surprise with completion of his twin-engined W.8 civil airliner. On 4 December, after an initial short test kept secret from reporters, on only the second flight the prototype made its maiden trip to Paris in 2 hr 10 min, flown by Robert Bager, chief pilot of Handley Page Transport Ltd. Here was the world's first splendid contribution towards swift and safe but reasonably economic air transport, for this 75 ft span machine, with its powerful twin Lions, could carry 15 to 20 passengers with more comfort than ever before. In

The 75 ft Handley Page W.8 had a fuselage constructed from an O/400 according to conversion number HP15 on the rear fuselage. After the Paris Aero Show in the winter 1919–20 it was entered in the Air Ministry's Commercial Aeroplane Competition. Cruising speed was 90 mph, wing loading $8\frac{1}{2}$ lb/sq ft and power loading 13·6 lb/hp.

appearance the same master hand could be discerned which had produced the huge V/1500. That was Volkert's. H.P. was well pleased – but to the initiated it was noticeable that the wings did not incorporate the leading edge winglets which were the subject of Patent 157,567 granted to him on 24 October 'to prevent burbling or eddying of the air above the leading edge of a plane set at a considerable angle of incidence, the plane being formed with slots extending transversely across the line of flight, and having the opening of each slot on the under surface of the wing in advance of the opening on the upper surface'. Absence of the device did not indicate uncertainty of the value of his invention; merely that it would have been injudicious to incorporate slots before the patent was granted. Handley Page's overwhelming preoccupation had been to get the machine ready and test-flown well before the Paris show. The big biplane was resplendent in all-ivory livery and glittering black engine nacelles. A striking feature was the immense balanced rudder with large fin and monoplane tailplane.

Meanwhile Ross Smith and his brother were ploughing steadily towards

Australia. They reached Calcutta on 28 November and Rangoon at noon on 30 November. Their report from Singapore on 4 December stated: 'We left Rangoon at seven on December 1st and arrived at Bangkok at one. We passed through a heavy storm above the mountains, and thick cloud delayed us. We climbed to 9,000 feet to get over the worst of it. We left Bangkok on December 2nd and were escorted to Singora for the first 50 miles by four Siamese machines. Course south along the coast of Malaya for the first two hours was good, but then we met a heavy monsoon. It was necessary to fly at 500 feet for three hours following the coast, almost blinded by rain, and the country was impossible for landing. The aerodrome at Singora is bad and stumpy. We had to land cross-wind on a small dry patch, but in taxying the tailskid caught a root and broke a fitting. The damage is not serious.'

That night the squalls were so heavy that the Vimy crew had to hold the machine down until dawn, and then in the torrential rain that followed on the 3rd the skid was repaired and petrol received from Penang. On the 4th they took off, heading for Java where they landed at Kalidjatti, near Batavia, at 4.07 p.m. that day.

'This was a distance of nearly 700 miles, and the worst stage of the journey as regards landing grounds,' wrote Ross Smith. 'Next day we went to Sourabaya where the aerodrome was being constructed on reclaimed land which was apparently hard and fit to land on, but in reality was soft underneath. We landed successfully, but while taxying the machine sunk to the axles. It was necessary to obtain assistance of 200 coolies to get the machine out again, and we decided the only possible way to take-off would be to make a road of bamboo mats for the wheels. By dark we had constructed a thin road sufficient to get the machine to the end of the ground, and it took us seven hours to move 400 yards. By 9 o'clock next morning we had built a road about 300 yards in length, and attempted to start after running about 500 yards but some of the mats flew up and caught in the tail and swerved the machine round, with the result that we were once more badly bogged. Again we dug her out and got back to the starting place, and widened the track by lacing mats together until we had a track 350 yards in length and 20 yards wide. We then started up again and succeeded in getting off with bamboo flying in all directions.

'We were thankful to leave Sourabaya and much relieved to be in the air once more. We then flew due east along the coast to the islands and landed at Bima where there is an excellent Dutch aerodrome. Next morning we started for Atamboca, in Timor Island, where there is a Dutch military station.

'On Wednesday December 10th we were up at dawn and rode from the military camp to the aerodrome, a distance of 3 miles, on Timor ponies. Just as we were ready to start a thick fog came on which delayed us about two hours. However at 8.30 the fog lifted and we started off and headed for Darwin by compass. After being out of sight of land for about two hours we spotted the cruiser *Sydney* in exactly the position we had asked

her to be in in case of need. We were relieved to see her, as we felt that if anything did go wrong over the water we would have friends to rescue us. We had no wireless on board, so we dropped a message in a bottle attached to a small parachute, stating all was well. Two hours after leaving the *Sydney* we sighted Bathurst Island, our first glimpse of Australia, and about three-quarters of an hour later arrived at Port Darwin.'

The first great Empire link had been achieved. In 124 hours flying they had covered 11,500 miles in 29 days. From HM the King came a cable: 'Delighted at your safe arrival. Your success will bring Australia nearer to the Mother Country, and I warmly congratulate you and your crew. George R.I.' Presently the two brothers would receive knighthoods of the Order of the British Empire, and the two sergeant crewmen would be awarded the new Air Force Cross.

This great victory for the Vickers organization was skilfully emphasized on 15 December at the new Science Museum buildings at South Kensington when the nation was presented with the actual Vickers Vimy which Sir John Alcock and Lieut Arthur Whitten Brown had flown across the Atlantic six months earlier. In his speech when handing over the gift Mr Douglas Vickers said all would agree that this aeroplane constituted an historical landmark; it was not in any way specially made for the flight, but was to have been a Berlin bomber. He considered the flight from London to Australia as perhaps even greater than the Atlantic effort, for its difficulties had included a new route barely surveyed, and tremendous variations of climates. He did not mention that Ross Smith, for all his courage and determination, had the great advantage that he had previously surveyed the route under Air Ministry auspices.

The difficulties of that route were tragically revealed when yet another competitor met disaster, for only two days earlier Lloyd's agent at Corfu had telegraphed: 'Information just received British aircraft wrecked off

The two-seat long-range Martinsyde Type A Mk I., fitted with an enlarged rudder and painted pale blue, about to take off on 12 December, 1919, for its attempted flight to Australia. Three similar aircraft were built as long-range mailplanes and five others were built with four-seat cabins. (*Flight Photo.*)

St George's Bay Corfu December 10th; no hope of survival; identification mark GUMR, Capt C. E. Howell, Melbourne.' That was the Martinsyde. Meanwhile the Sopwith Wallaby was still struggling with bad weather, and the Blackburn Kangaroo had a major engine failure.

While aviation was making history, Lady Astor introduced a new age in the House of Commons when on 1 December she was received as the first Lady Member, coincidently with a Bill admitting women to the profession of Law. But it was India and Ireland which were worrying Parliament. Indian nationalistic feeling was being placated by a complicated system of revised representation and authority. Passive resistance might suffice in India, but Ireland was facing more active dangers. Eamon De Valera, the Sinn Feiner, had escaped from Lincoln gaol in the spring, and since then there had been mounting attacks upon the police. In December they were growing more frequent, culminating in an attempt to murder General French when his car was ambushed. Urgently Lloyd George produced a scheme for Home Rule and separation of Ulster, with a system of dual Parliaments and a single Federal Council for the whole of Ireland, though it was far from certain that the growing lawlessness could be countered by such new methods of conciliation. Yet because Ireland was separated from England by a strip of sea, her complexities remained too remote for English people and were no more than interesting news of the strong-headedness of the wilful Irish.

Closer to the hearts of Britons was the return of the Prince of Wales in HMS *Renown* from a tour of the USA and Canada. There he had been a tremendous success – for his charm captivated New York and Montreal no less than his native land, and people saw in his youthful simplicity, and enjoyment of riding and games, the embodiment of the new young world.

Of the old generation a great aeronautical pioneer passed away on 11 December – José Weiss, that exponent of swept and twisted wing

Oscar Gnosspelius at Rochester in 1919 with his experimental man-powered ornithopter. Gnosspelius, an idealist seeking neither fame nor money, was particularly interested in bird flight. (*Short Bros.*)

The first of the four-seat Vickers Viking amphibians was registered on 21 October, 1919, but fatally crashed two months later piloted by the conqueror of the Atlantic – Sir John Alcock. It was a type to which Vickers returned in the 1930s with the Walrus. (*Vickers Ltd.*)

stability who had so enchanted young Handley Page in days long before the war, and who equally had influenced another youngster, Gordon England, to engage in flying. Recently Weiss, with his co-artist friend Keith, had been experimenting with a flapping-wing machine actuated by man-power, much as Gnosspelius was hopefully experimenting with at Shorts. But first and foremost Weiss was an artist, and though little appreciated in England he commanded great success in America. By nature a philosopher it grieved him that the aeroplane which he had dreamed a means of peaceful communication had become an evil of war, nor was it any consolation that he had introduced Handley Page to aeronautical fortune.

Weiss might be unknown to the majority of those engaged in the post-war aircraft industry, for they were not even teenagers when he commenced his experiments – but it came as a shock to all when on the following Thursday, 18 December, Sir John Alcock died in hospital at Rouen as the result of a crash at Côte d'Évrard where he had attempted a forced landing in bad visibility with the new Vickers Viking amphibious biplane which he was flying to the Paris Aero Show for its introduction to the world. A rain-swept sky with low cloud at Brooklands, coupled with widespread fog reported in northern France, had prompted the management at Vickers to dissuade him from the flight, particularly as he was flying solo without navigator, but the victor of the Atlantic was confident he could overcome such weather. Over Normandy he became lost above dense fog. In an attempt at landing to discover his whereabouts the Viking struck a tree, swung into the ground, and Alcock was thrown out and fatally injured.

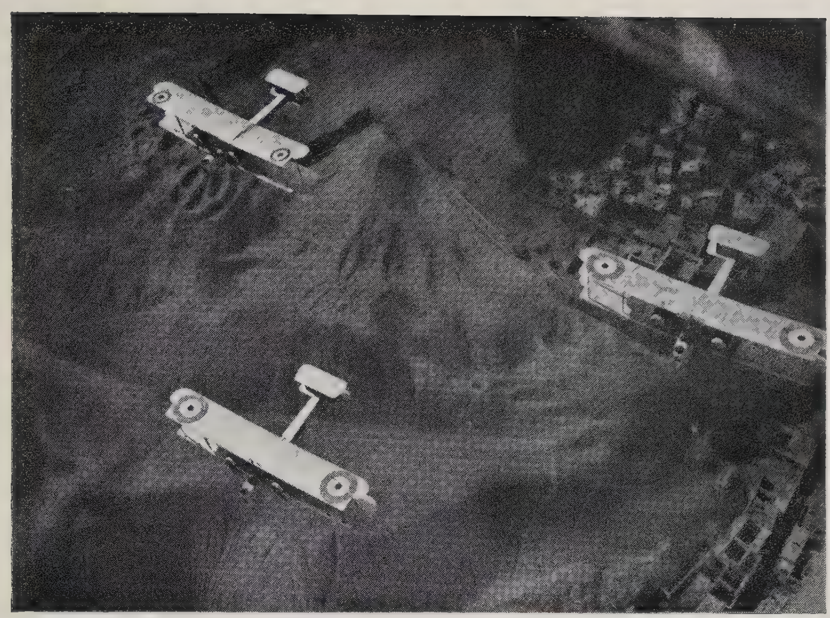
All England was deeply affected. It seemed incredible that the great conqueror had met his fate. Every newspaper offered long obituaries emphasizing the great place in history that this modest and unassuming man had attained. Indeed, he received the sympathy and admiration of the whole world. Meanwhile his young brother, E. S. J. Alcock, was learning

to fly, maybe dreaming of the long and distinguished career that he might have in pioneering commercial air routes by landplane and flying-boat.

In the stress of greater events, the result of Miss Douglas-Pennant's appeal from dismissal as Commandant of the Women's Royal Air Force passed unnoticed. In October Lloyd George had been forced to appoint Cecil Harmsworth to conduct an enquiry. He now reported: 'Miss Douglas-Pennant is shown to be a woman full of zeal and activity, much impressed with her own importance, very reckless in her imputations upon others, and one not at all likely to get the best out of those with whom she had to work or over whom she had authority. The story of the intrigues against her has originated, in our opinion, in her distortion of events and from her incapacity to see things in their true perspective.' Time, expenditure, and disquiet had been occasioned over a matter which might seem trivial, but it was important in assuring that the WRAF would be effective under its new command, for women would be required again if ever there was another war.

10

Air Marshal Sir Hugh Trenchard, Chief of the Air Staff, nicknamed 'Boom', was laying a firm foundation for the Royal Air Force. On 13 December the Air Ministry issued a Memorandum he had written, prefixed with a note by Winston Churchill stating that the scheme was prepared under his direction and approved in principle by the Cabinet. With the eye of the visionary, Trenchard wrote: 'The Force may in fact be compared to the gourd of the prophet Jonah. The necessities of war created it in a night, but the economies of peace have to a large extent caused it to wither in a day, and we are now faced with the necessity of replacing it with a plant of deeper root. As in Nature, decay fosters growth, and the new plant has a fruitful soil from which to spring. The principle to be kept in mind in forming the framework of the Air Service is that in the future the main portion of it will consist of an Independent Force together with Service personnel required in carrying out Aeronautical Research. In addition there will be a small part of it specially trained for work with the Navy, and a small part specially trained for work with the Army – these two small portions probably becoming, in the future, an arm of the older Services. It may be that the main portion, the Independent Air Force, will grow larger and larger, and become more and more a predominating factor in all types of warfare.' There followed detailed analysis of the problem, based on the Government's belief that for some years there would be no general mobilization, leading to proposals of eight Squadrons for India and three for Mesopotamia and seven for Egypt, together with a Strike Force, Training Wing, Army Co-operation, and Fleet aircraft, as well as a Communication Squadron and four Experimental Stations. Based on this immediate foundation for 1920–1, Trenchard defined the increases required for the subsequent three years. Reserves, channels of entry, and methods of training, together with higher organization were discussed, and the



Replacing the RAF Handley Page O/400s as early as July 1919 were Vickers Vimys operated by No. 58 Squadron in Egypt and capable of carrying eighteen 112 lb bombs and two of 230 lb.

necessity for large capital outlay and accommodation was made clear. But what was a guiding star to the British aircraft industry lay in the paragraph entitled Research: 'One matter of supreme importance is the provision to be made for Research. The Departments of Supply and Research are being transferred from the Ministry of Munitions to the Air Ministry, and a portion of the Experimental Establishments (Farnborough, Biggin Hill, Martlesham, Grain, and airship research at Cardington and Howden) are a charge on the Air Force votes. Steady and uninterrupted progress in Research is vital to the efficiency of the Air Force, and to the development of aviation generally, and on it depends both the elimination of accidents and the retention of the leading position we have established at such heavy cost during the war.'

That British aircraft constructors were determined to maintain their position and would challenge every European manufacturer on his home ground was shown by their full representation at the great Exposition of aeronautic *matériel* at the Grand Palais in Paris which opened exactly 11 years since the first Aero Show. They were Airco, Boulton and Paul, Bristol, Handley Page, Westland, and Vickers – and engines were shown by the Napier, Sunbeam, Rolls-Royce, Siddeley-Deasy, and Cosmos companies. It had been the intention of the Society of British Aircraft Constructors to have a single big stand which would represent the entire aircraft industry, but they were told with typical Gallic insistence that as

the SBAC did not manufacture aircraft this was impossible under the rules of the Exposition. But Paris spun its inevitable spell. There at the lower end of the Champs Élysées was the massive Grand Palais into which one ascended by a big flight of stairs – and inside, far below the high glass roof, was the great and exciting collection of new aeroplanes on their decorated and placarded stands. Men of every nationality thronged the aisles and talked to exhibitors, and crowds of French men and women wholly unconnected with aircraft filed round in a crowd with muttered exclamations of *Incroyable!*

Ready for Paris – the prototype Westland Limousine and the first production model of this business executive aircraft are shown about to leave Yeovil for Le Bourget, respectively piloted by ex-Sgt W. G. Gibson and Capt A. S. Keep.

A visitor wrote: 'Judging from what one saw in Paris, the French aircraft industry has suffered more from official interference than has the British industry. There was hardly a French aeroplane which showed originality in general layout or aerodynamic design. All were good examples of ordinary design and construction. A few were striking. None inspired that admiration for originality one felt at pre-war Paris shows.

'Those British firms which had the pluck and energy, and the financial strength, to exhibit their machines have not only sown seed from which they will reap a rich harvest in time to come. They have in fact conferred a lasting benefit on British industry in general and on the British aircraft

At the Paris Salon the new Bristol Bullet racer was displayed with a Tourer and the Babe, all neatly finished in black livery. But the Bullet, although intended as a test bed for the Cosmos Jupiter had only a mock-up engine at this stage. (*Bristol Aeroplane Co.*)

industry in particular. Their exhibits were in fact the best things in the whole show for they displayed originality of idea as well as excellence of workmanship and aerodynamic design.

'The great W.8 Handley Page impressed everybody with the neatness of design and luxury of its accommodation, and with the power of its Napier engines. It was the *clou* of the show, and a queue of hundreds of people passed continuously across the stand to gaze into the elaborate interior of the saloon.

The second Westland Limousine was handsome for its day, and had a Sopwith type fin which was larger than the prototype's, and the Rolls-Royce Falcon was mounted with a large rectangular radiator replacing that of Bristol Fighter type.

'The Airco stand, displaying elegance of arrangement as a whole, exhibited a beautifully finished Airco 16 with Napier.

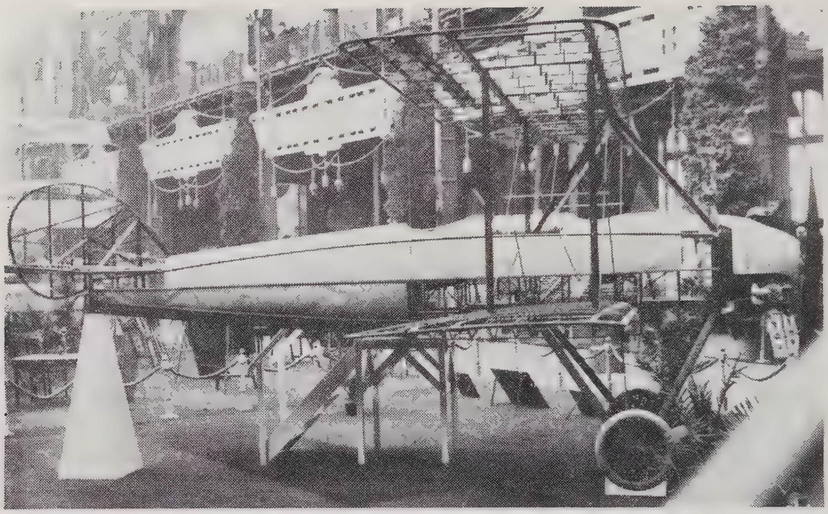
'The Bristol stand, with its Cosmos-engined Bullet, its Puma-engined Tourer, and its Siddeley-engined Babe had a businesslike appearance which was most impressive and showed well the cleanness of Captain Barnwell's design.

'The Vickers stand, despite the disaster of the Viking smash, showed by means of models of machines designed by Mr Pierson, by the passenger compartment of a commercial Vimy, and by a great number of parts and fittings, the capabilities of that great armament firm.

'The Westland Co's Limousine, with its Falcon engine, taught a useful lesson in the art of designing a comparatively small machine expressly for passenger carrying so that it shall be really efficient, and it indicated the high place of Mr Bruce among the aeroplane designers.

'And the all-steel Boulton and Paul biplane displayed Mr North's originality of idea and sound mechanical knowledge in a way which should be a pattern to future exhibitors. Incidentally, so far as one could see it was the most advanced example of constructional thought in the whole show.'

Indeed, John North's contribution showed greater technical advance



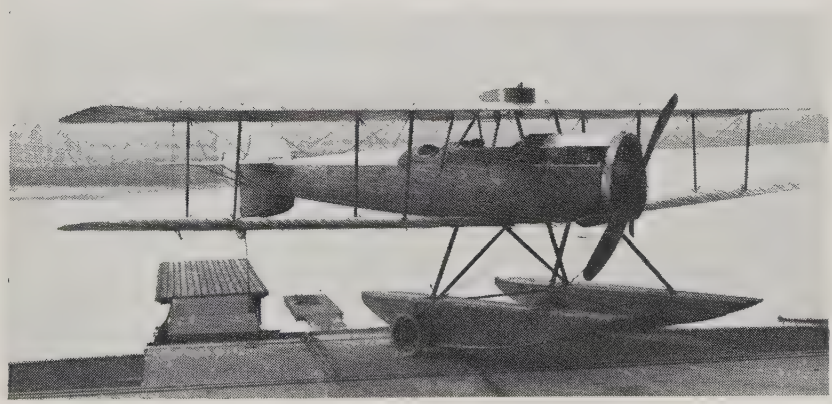
The advent of all-metal structures was emphasized by J. D. North's costly sports Boulton and Paul P.9, powered by the then untested Cosmos Lucifer three-cylinder radial. The aircraft with structure exposed is seen at the 1919–20 Paris Aero Show. (*Flight Photo.*)

than any other machine, though its significance was not widely appreciated. Patent 159,644 covering his form of metal construction had only been issued in the first week of December. Essentially he used a conventional girder fuselage of tubes, but covered it with sheets of aluminium or fibre 'arranged outside a plurality of hoops of sheet metal, which are placed at distances apart in places transversed to the longitudinal axis of the structure, and inside a plurality of longitudinal sheet metal members, the whole being riveted together'. At the front of the fuselage he employed a patented engine plate of stamped sheet metal in box-like form which, following Harold Bolas's line of thought with the Panther, was hinged so that it could be swung outward to give access to the back of the engine. The patented wings – based on Dr Thurston's work – had an all-metal structure with 'crinkly' steel spars and built-up ribs of channelled section made from bent sheet metal. Every metal unit was protected from corrosion by a patented system of 'sheradizing' or alloying the steel with a high percentage of chromium and then polishing, and all parts were secured with rivets or bolts of stainless steel.

A notable absentee was the B.A.T. commercial four-seat F.K.26. It was rumoured that British Aerial Transport and their associated company the Alliance Aeroplane Co, both of the Waring and Gillow Group, were facing financial difficulties, for Koolhoven had just left the company and for some weeks the foremen and men had been under notice. On 31 December the last of Koolhoven's personal staff left, and only a care and maintenance group remained, under the charge of Chris Draper, to service and demonstrate the three or four machines housed at Hendon.

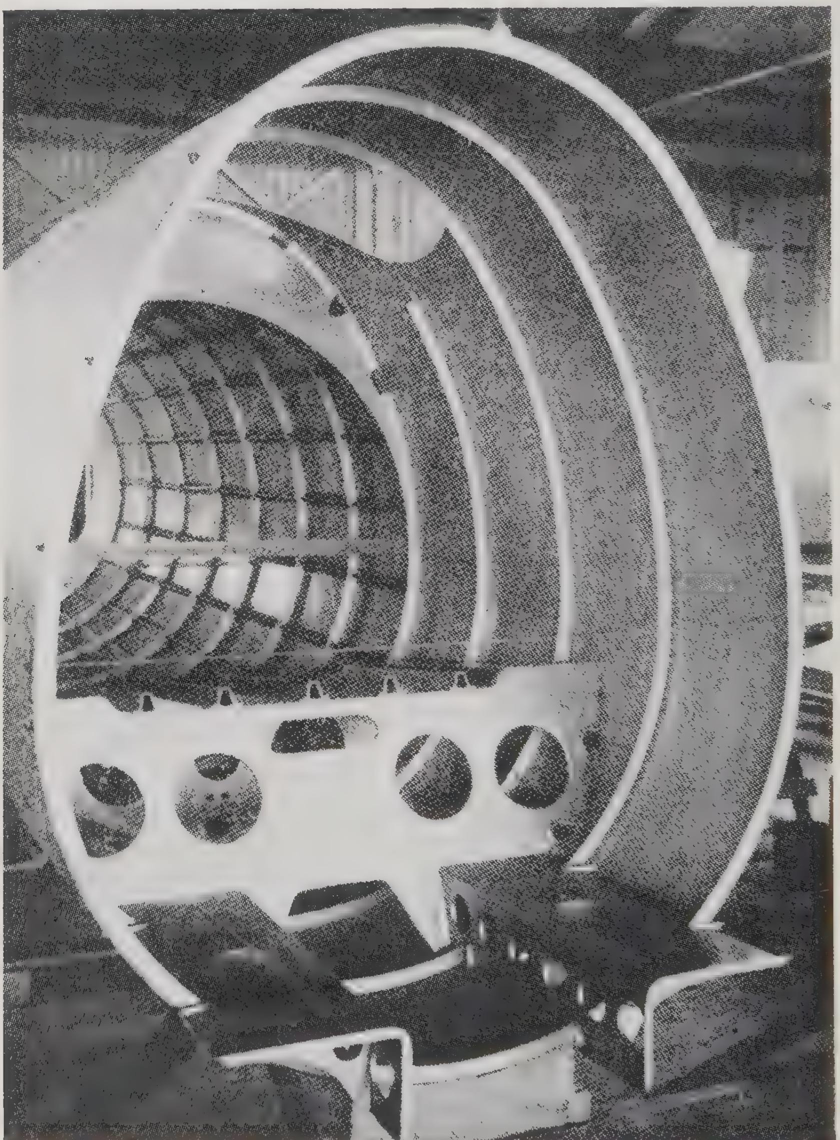
For a very different reason Oswald Short's company was not represented. He had in mind the British Aero Show, which recently had been announced by the SBAC as opening on 9 July, 1920, at Olympia, for the venue in displaying to the world his secret new techniques. His immediate interest had waned in the conventional Sporting Type Seaplane which Francis Webber had derived from the N.2B, using a semi-monocoque fuselage with curved sides in plywood and wings employing steel-tube spars and fret-sawn plywood ribs. The prototype had been flown by John Parker on 10 December, but there seemed very limited prospect of sales. The factory looked starkly empty – for the last forty F.5 flying-boats had been cancelled, and even the larger but similar Cromarty hull being built to Admiralty N.3 requirements for Fleet co-operation had lost priority due to lack of Admiralty interest.

If anything, the depressing situation spurred Oswald to put into practice his long expressed conviction that the time and techniques were ready for an all-metal aeroplane with fuselage of streamlined monocoque form using wrapped duralumin sheets to make a load-carrying structure without relying on longerons. As a result of his sequence of tests on the relative corrosion of duralumin and mild steel of equal strength, when subjected to the same conditions of alternative immersion in salt water and air, he had become sufficiently convinced by September of the practicability of duralumin construction to build a conical section of fuselage skinned with this material on similar riveted hoops. Tested under a hydraulic pressure of 7 lb/sq in, strength and tightness proved satisfactory, and he proceeded to design his envisaged biplane, which was of much the same size and geometry as Webber's recent seaplane. Not only did it have a beautifully streamlined fuselage but also a special form of all-metal wings in which thin aluminium skinning with upturned edges was applied in chordwise strips between



Shorts' first post-war design was the four-seat 160 hp Sporting Type Seaplane based on cancelled design work for an RAF trainer. Named *Shrimp*, it was initially flown by John Lankester Parker on 10 December, 1919. (*Courtesy C. H. Barnes.*)

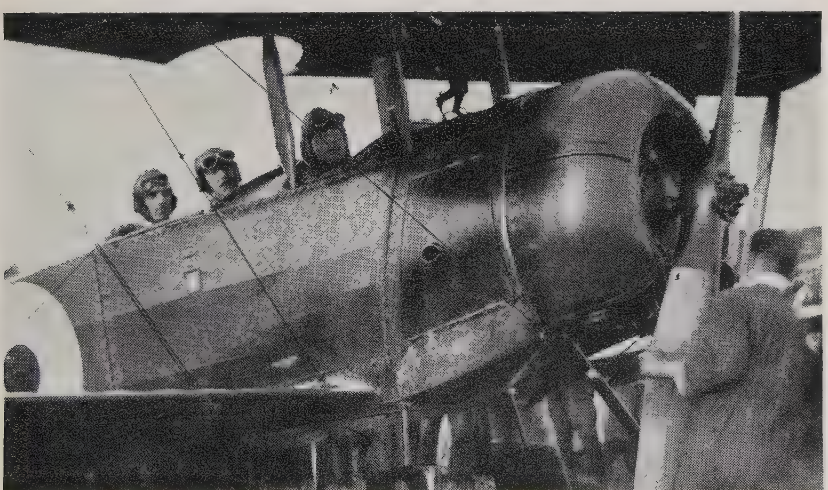
constant chord duralumin plate ribs of slightly greater depth than the wing-section and riveted directly together through an external capping channel. For the fuselage he envisaged L-section oval frames with intercostal



Towards the end of 1919 Oswald Short showed by his enterprise in constructing a private venture duralumin-structured monocoque fuselage the pathway to commercial and military designs of a decade later – but official 'experts' were sceptical. (*H. O. Short.*)

stringers cleated to them, and the wrapped duralumin skinning riveted to the frames. C. H. Barnes records in his history, *Shorts Aircraft since 1900*, that: 'It was a constant feature of Short monocoque construction for many years that the frames were never cut or notched for continuous stringers; Oswald Short was very farseeing and insisted on avoiding stress raisers, such as notches in primary structures, from which cracks could originate.' To keep the nose entry as slender as possible he selected a 240 hp Siddeley Puma as powerplant, though wryly explained to me that it was a Disposal engine to keep the cost down. He added: 'When I asked the Deputy DTD to come and see the plans and drawings he waited some time, and then sent two of his subordinates from his technical staff. They expressed the opinion that I had gone too far!' So often the vagaries of official rejection or acceptance of unconventional technical development appear to depend not so much on scientific merits, but on the personality of the proposer – his geniality, strength of character, reputation for success – and Oswald Short could be hard and difficult to those he did not like.

He was not alone. A case in point was that dynamic genius and ex-superintendent of the Torpedo Factory, Louis Brennan, now 62, who since 1896 had specialized on gyroscopically stabilized mono-railcars, and more recently had been planning a helicopter which he described as a gyroplane. In 1916 the Munitions Department had advised the Government to take active interest in his proposals, and arranged for them to be protected by a Secret Patent; but only now, when Pescara was already leading the way in Italy, had the Air Ministry decided that the RAE's rotating wing research on some of Brennan's rotor schemes merited



Lieut Alan J. Cobham, in the front cockpit of the Berkshire Aviation Tours khaki-painted Avro 504K *Mayfly*, sold joy-rides at the little airfield at Reading which had been used for R.E.8s during the war. As a schoolboy the author had his first flight on this occasion. (*J. D. V. Holmes.*)

Undreaming of a great flying career ahead Capt Hubert Broad embarked on civil life as a joy-riding pilot in Canada and then in Wales, purchasing this Boulton and Paul built Sopwith Camel in December 1919 for aerobatic displays. (*P. D. Roberts.*)

practical construction. Accordingly he was authorized to set up a helicopter section at Farnborough under his full personal control.

The British aircraft industry thought this a shocking waste of public money at a time when their own aspirations seemed doomed. In a confusion of hope and anxiety they awaited the advent of 1920 with the same restlessness as the many young war-time pilots who were determined that the coming year would see them established in civil aviation. Among them was 25-year-old Lieut Alan Cobham, an Indian Army officer who had transferred after three years to the RFC and with his friend J. D. V. Holmes, a pilot of 19 Squadron who had been prisoner of war since 1917, was hoping that the activities of their newly established joy-riding company, the Berkshire Aviation Co, would yield at least a living if not a golden harvest. Another was a young ex-RNAS pilot called Hubert Broad who had learnt to fly at Hendon in 1915, when he was 18, and who early in September had bought a Sopwith Camel originally built by Boulton and Paul as H.2700, which he registered as G-EAWN. There were scores and scores of others pinning their faith on the unguessable future. Was this not the dawn of a new age? Had not the war proved it?

But it was on the shoulders of the original pioneers on which the future really rested. And they were apprehensive, for it depended not on their idealism and sense of vocation but on the complex issues of finance. George Holt Thomas, who had so boldly advertised his empire as 'The largest aircraft enterprise in the world', was 50 years old and an ailing man. At the last shareholders' meeting on 9 December he had warned that as a result of meeting the great demands of war the company had been left with very large factories, and the problem was to fill them with post-war products and yet maintain a fully functioning aircraft design and experimental department. Construction of motor-car bodies, with machinery ordered from the USA, would be their first line of attack, but it was necessary to capitalize the reserves and to bring in new working capital, despite a net profit for the past year of £119,652. He did not divulge that he was

currently negotiating with the Birmingham Small Arms Co Ltd for an amalgamation by exchange of shares. What the new policy might be was anyone's guess.

Of other major pre-war pioneer aircraft industrialists, Alliott Verdon Roe, OBE, was 42; Oswald Short was 36; Frederick Handley Page, CBE, was an elderly looking 34; Robert Blackburn, OBE, was the same age; and Tom Sopwith, CBE, was only 31. Of their designer contemporaries, Geoffrey de Havilland, OBE, was 37; Frank Barnwell, OBE, BSc, was 39; Fred Green was 37, and his erstwhile novice Henry Folland was 30. Reginald Pierson, BSc, was the most publicized because of his Atlantic and Australian successes, but was only 26 like Roy Chadwick of Avros and John North. Among established management newcomers Robert Bruce, OBE, MSc, was the oldest at 44, and Richard Fairey, MBE, his contemporary in time as a manufacturer, was 32. At Supermarine, Hargreaves, the chief designer, had just left, and 24-year old Reginald Mitchell took his place.

The year on which these men looked back had been one of extremes in the history of aeronautics, during which the aircraft industry had been reduced from its position among the greatest and most important in all Britain to become the smallest as far as output was concerned, and therefore was now one of the least important. As C. G. Grey said: 'It has seen firms which made hundreds of thousands of pounds out of building aeroplanes during the war shut down their aircraft departments and dismiss their skilled staff, and it has seen other firms which struggled gamely through bad times before the war spending their hard-earned and overtaxed war profits in perfecting aircraft for peaceful purposes. It has seen men who came into the aircraft business during the war, and were given titles and honours for their services to aviation, turn their backs on aircraft and return to their normal commercialism – while the pioneers of aviation, who have received nothing better than a few OBEs, turn their backs on their

In hope of a gay and better future after the drabness of war years, privately owned aircraft were often brightly painted. Here a red and white Sopwith Snipe is seen on a visit to Yeovil.

The Bristol Badger F.2c with its uncowled Cosmos Jupiter reveals the big propeller required and its marginal clearance. Maximum speed was 142 mph. The Jupiter engine was destined to play a major role in the development of civil and military aviation in the 1920s and 1930s.

scanty war profits and return to their normal work of pioneering aeronautical developments in new directions.

'It has seen the financiers of the country button their pockets tightly against all appeals to finance aeronautical undertakings, and it has seen a few firms and several individual pilots doing a highly profitable business in pleasure flying on absurdly small capital expenditure. It has seen the Press and Members of Parliament wildly excited over the integrity of a single Air Force and the maintenance of a separate Air Ministry, and it has seen the Government reduce the said Air Force to a smaller number of Service squadrons at home than existed before the war.'

But there had been great and resounding achievements. British aviation had led the way in traversing the Atlantic with a single leap for the first time in the world's history; there had been that swift progression of a similar Vickers Vimy across half the world and its chancy weather to achieve Australia. Handley Page not only had designed and built what seemed a remarkably advanced civil airliner, but had initiated his still unpublicized invention of securing greater lift from a wing than had ever been achieved before, and it seemed that future aeroplanes might fly with only half the usual wing area if multi-slots were used. They might well be rivalled by this hovering machine of Brennan's. And there was this secret aeroplane which Oswald Short was building in which even the wing covering was of metal – though the essence of its design was that instead of making metal-structured fuselage frameworks merely covered with dural instead of fabric, he was relying on the intrinsic strength in bending and torsion of a monocoque shell. Then there were all these new engines – and what of airships? Surely new horizons were opening?

APPENDIX I

Company Representation of Initial SBAC Members

Aircraft Manufacturing Co Ltd	represented by	G. Holt Thomas
Airships, Ltd	,, ,,	G. Holt Thomas
The Austin Motor Co (1914) Ltd	,, ,,	Herbert Austin
William Beardmore & Co Ltd	,, ,,	C. G. Gourley
The Blackburn Aeroplane and Motor Co Ltd	,, ,,	Robert Blackburn
Boulton and Paul, Ltd	,, ,,	G. E. ffiske
The Brush Electrical Engineering Co Ltd	,, ,,	B. Broadhurst
The British and Colonial Aeroplane Co Ltd	,, ,,	H. White Smith
The Coventry Ordnance Works, Ltd	,, ,,	Lieut-Col Mansell
The Daimler Co Ltd	,, ,,	E. M. C. Instone
Darracq Motor Engineering Co Ltd	,, ,,	Robert Crossley
William Denny and Brothers	,, ,,	Sir Archibald Denny
The Dudbridge Iron Works, Ltd	,, ,,	Francis J. Platt
The Grahame-White Aviation Co Ltd	,, ,,	F. H. Payne
Handley Page, Ltd	,, ,,	F. Handley Page
Hewlett and Blondeau, Ltd	,, ,,	G. Blondeau
Jouques Aviation Works	,, ,,	L. A. Jouques
Mann and Grimmer, Ltd	,, ,,	R. P. Grimmer
Martinsyde, Ltd	,, ,,	Hamilton Fulton
Mann, Egerton & Co Ltd	,, ,,	G. N. C. Mann
D. Napier & Son, Ltd	,, ,,	H. T. Vane
Phoenix Dynamo Manufacturing Co	,, ,,	P. J. Pybus
Parnall & Sons	,, ,,	George G. Parnall
Robey & Co Ltd	,, ,,	Ashley Pope
A. V. Roe & Co Ltd	,, ,,	H. V. Roe
Ruston, Proctor & Co Ltd	,, ,,	F. H. Livens
The Standard Motor Co Ltd	,, ,,	R. W. Maudslay
S. E. Saunders, Ltd	,, ,,	S. E. Saunders
Short Bros	,, ,,	E. B. Parker
The Sopwith Aviation Co Ltd	,, ,,	R. O. Carey
The Sunbeam Motor Car Co Ltd	,, ,,	L. Coatalen
The Siddeley-Deasy Motor Car Co Ltd	,, ,,	J. D. Siddeley
Fredk Sage & Co Ltd	,, ,,	E. C. Gordon England

The Norman Thompson Flight Co Ltd	,,	,,	Norman A. Thompson
Vickers, Ltd	,,	,,	Major H. E. Wood
Westland Aircraft Works	,,	,,	E. W. Petter
J. Samuel White & Co Ltd	,,	,,	Howard T. Wright
G. & J. Weir & Co Ltd	,,	,,	Major J. G. Weir
Wells Aviation Co Ltd	,,	,,	R. F. Wells
Whitehead Aircraft Co Ltd	,,	,,	J. A. Whitehead
Wolseley Motors, Ltd	,,	,,	B. Caillard

APPENDIX II

Handling Notes for Snipe 7F.1 Fighter

BECAUSE PILOTS and mechanics regarded the powerful B.R.2 engine with some awe the Snipe engine instructions took pains to ensure correct manipulation:

PETROL SYSTEM: The Snipe carries petrol for about $3\frac{1}{2}$ hours: about 2 hours in the back tank, and $1\frac{1}{2}$ hours in the front tank. The carburettor is fed by gravity from the front tank, controlled by the petrol tap and fine adjustment.

The petrol system, called the 'Badin system' is simple and gives very little trouble. Petrol is automatically fed from the main tank to the gravity tank, and then to the carburettor. A sight feed in which a diaphragm can be seen moving up and down as long as petrol is passing through the pipe is placed on the petrol pipe connecting the two tanks.

An overflow pipe is fitted from the gravity tank back to the main tank. A Weyman hand pump is also fitted, so that in an emergency petrol can be pumped from the main tank to the gravity tank.

STARTING AND RUNNING: Petrol taps must be turned on. The throttle should be fully opened and the fine adjustment opened about one-third of the quadrant. Mechanics must close the air intake pipes by holding their hands over them. After sucking in, the fine adjustment should be closed, leaving the throttle lever one-quarter open. When both switches have been switched on and the engine first fires, the fine adjustment should be opened slowly until smooth running is obtained at about 600 rpm or slower for about half a minute. This should be continued until the oil can be seen moving in the pulsometer glass.

In cold weather, each cylinder should be doped through the exhaust valve. The throttle should be opened one-third of the quadrant, leaving the fine adjustment closed, and the propeller turned backwards for about four revolutions; after this, the propeller should be swung in the ordinary manner.

To tune up the engine, the throttle should be opened steadily. When it begins to misfire, the fine adjustment must be opened until firing is even, then the throttle must be opened again, followed if necessary with the fine adjustment until the engine is giving full rpm. The throttle should always be opened *first*, as this uses up any surplus petrol that may have gathered in the induction pipe and crankcase. The engine should always be run on as little petrol as possible, i.e. the petrol supply should be cut down by pulling the fine adjustment back. This keeps the engine cool and clean. The engine must not be run for more than 20 seconds 'all out' on the ground. It is important that the fine adjustment be set so that the engine is giving its rpm on as little petrol as possible; the throttle should then be pulled back steadily until the engine is running slowly. The fine adjustment should not be pulled back until the engine first begins to misfire.

Handling the aeroplane was dealt with in more general terms:

TAKING OFF: The Snipe taxies steadily, but no attempt should be made to turn in a strong wind without the assistance of mechanics on the wing-tips. When the aeroplane is being taxied, the engine should not be run on the switch. The tailplane lever should be in the half-way position. A slight forward pressure on the control column is necessary to lift the tail off the ground. The Snipe will take herself off after a short run at a flying speed of 50 mph.

FLYING LEVEL: An average cruising speed of about 90 mph can be maintained with the engine throttled back to 1,000 rpm. At low altitudes, a considerably greater flying speed can be attained without strain, provided the engine does not exceed its maximum rpm.

CLIMBING: The best climbing speed is about 65 mph. The bottom of the front centre-section struts are just above the horizon. The tailplane should be adjusted so that the aeroplane climbs 'hands off'.

DIVING: The Snipe has a good steady dive but gathers speed rather quickly. The pilot should set forward the tailplane adjustment lever when diving, and should use it when coming out of a dive.

TURNING: The lateral control is heavier than on the Avro. On a turn to port, the nose has a tendency to go up, and a lot of bottom rudder is required to keep the nose on the horizon. In a steep turn to port, the control column should be pulled back slightly; if it is pulled right back, the aeroplane will stall and spin. In a turn to starboard, the nose has a tendency to go down. Top rudder is therefore necessary, and the control column may be pulled right back. For quick turns, the tail lever should be set right back.

LANDING: When the Snipe is being glided, the tailplane adjustment lever should be set right back. The normal gliding speed is 65 mph. Throttle and fine adjustment should be closed. On a long glide, the throttle should be opened every 2,000 ft, and if the engine does not fire, the fine adjustment should be opened until it does. This clears all surplus oil

and prevents the plugs from getting oiled up. When at about 200 ft, the throttle should be opened until the engine gives about 600 rpm, then switched off and on by the 'blip' switch on the control column. The aeroplane should be taxied in on the throttle. The engine must not be 'buzzed' over 700 rpm. The tailplane adjustment lever should be set right back when near the ground. The Snipe has a flat gliding angle, lands slowly, and only runs a short distance on the ground. When the aeroplane is standing in the sheds, the plugs must be removed from the two bottom cylinders.

APPENDIX III

Avro 504K Weights

(110 hp Le Rhône)

Wings, with ailerons and centre-section	260½ lb	
Interplane struts	41 lb	
Interplane wires	24½ lb	
Wing skids	2 lb	
Wing total		328 lb
Tailplane with supports	21½ lb	
Elevators	12 lb	
Rudder with levers and wires	8½ lb	
Tail total		42 lb
Fuselage and engine housing	270 lb	
Flying controls and wires	30 lb	
Miscellaneous, flying instruments, lighting	25 lb	
Undercarriage with axle and skids	65 lb	
Main wheels 100 by 700 mm.	40 lb	
Tailskid	6 lb	
Fuselage total		436 lb
110 hp Le Rhône	330 lb	
Propeller boss and bolts	41 lb	
Oil tanks, cooler and piping	15 lb	
Petrol tanks, piping and air pressure system	39 lb	
Engine total		425 lb
Crew of two	360 lb	
Petrol 25½ gallons	184 lb	
Oil 6 gallons	54 lb	
		598 lb
Total laden weight		1,829 lb

Wing loading, 5·37 lb/sq ft; power loading, 16·7 lb/hp. Permissible C.G. variation was 4·2 in. Maximum speed was 95 mph at ground level at 1,250 rpm, with 40 mph minimum speed at full load, and duration 3·7 hr at three-quarter power at 8,000 ft.

Tarrant Tabor Weights
(Six 450 hp Napier Lions)

Top wing	1,903 lb	
Middle wing	2,691 lb	
Bottom wing	1,833 lb	
Interplane struts	2,543 lb	
External bracing wires	608 lb	
Wing total		9,578 lb
Tailplanes	334 lb	
Elevators	117 lb	
Fins	98 lb	
Rudders	40 lb	
Tail total		589 lb
Fuselage	3,590 lb	
Undercarriage	2,582 lb	
Tailskid	60 lb	
Controls	501 lb	
Fuselage total		6,733 lb
Engines, propellers, radiators	7,200 lb	
Engine accessories	650 lb	
Tanks and 1,600 gal petrol	12,662 lb	
92 gal oil and tanks	1,050 lb	
Crew of five	1,080 lb	
Wireless telegraphy	100 lb	
Guns and ammunition	380 lb	
Bombs and gear	4,650 lb	
		27,772 lb
Total laden weight		44,672 lb

Wing loading, 9·0 lb/sq ft; power loading, 16·5 lb/hp. Estimated speed more than 110 mph. Normal duration 8 hr. Permissible C.G. variation approx. 13 in.

APPENDIX IV

Price of British Airframes and Engines

(Ministry of Munitions 'Priced Vocabulary of Aircraft Supplies 1918–19')

Aeroplanes

(less engine, instruments, and guns)

	£	s	d
Armstrong Whitworth F.K.3	1,127	10	0
Armstrong Whitworth F.K.8	1,365	17	0
Avro 504K	898	19	0
B.E.2c	1,072	10	0
B.E.2e	1,072	10	0
Bristol Scout	700	0	0
Bristol Monoplane	770	0	0
Bristol F.2B Fighter	1,350	19	0
De Havilland 1	1,100	0	0
De Havilland 4	1,424	10	0
De Havilland 5	874	0	0
De Havilland 6	841	10	0
De Havilland 9	1,473	5	0
De Havilland 9A	1,509	12	0
De Havilland 10	3,483	7	0
F.E.2b	1,521	13	4
F.E.2d	1,540	0	0
Handley Page O/400	6,000	0	0
Handley Page V/1500	12,500	0	0
Martinsyde F.4	1,142	2	0
Maurice Farman Shorthorn	1,005	8	0
R.E.7	1,886	10	0
R.E.8	1,232	0	0
S.E.5a	1,063	10	0
Sopwith Pup	710	18	0
Sopwith 1½-Strutter	842	6	0
Sopwith Camel F.1	874	10	0
Sopwith Dolphin	1,010	13	0
Sopwith Snipe (B.R.2)	945	17	0
Sopwith Salamander	1,138	0	0
Spad	1,045	0	0
Vickers F.B.27a Vimy	5,145	0	0

Seaplanes and Ships' Aeroplanes

	£	s	d
Fairey Campania seaplane	3,245	0	0
Hamble Baby seaplane	1,175	0	0
Short 184 seaplane	3,107	10	0
Short 320 seaplane	3,589	7	0
Sopwith Baby seaplane	1,072	10	0
Sopwith Pup ship's aeroplane	770	0	0
Sopwith 2F.1 ship's aeroplane	825	0	0
Sopwith Cuckoo torpedo aeroplane	1,613	10	0
Wight seaplane	2,970	0	0

Flying-boats

Felixstowe F.2A (including trolley)	6,738	0	0
Supermarine A.D.	2,853	8	0
Norman Thompson N.T.2B	1,477	0	0
Norman Thompson N.T.4 'Small America'	3,610	0	0

Sausage Balloons

Army R type	400	5	6
Naval M type	458	6	4

Engines

A.B.C. Dragonfly	320 hp	1,072	0	0
B.R.1	150 hp	643	10	0
B.R.2	200 hp	880	0	0
Beardmore	120 hp	825	0	0
Beardmore	160 hp	1,045	0	0
Clerget 7.Z	80 hp	484	0	0
Clerget 9B and 9Bf	130 hp	907	10	0
Curtiss OX-5	90 hp	693	10	0
Fiat A.12 bis	300 hp	1,617	0	0
Gnome	80 hp	430	0	0
Gnome Monosoupape	100 hp	696	0	0
Hispano-Suiza (French)	200 hp	1,004	0	0
Liberty	400 hp	1,215	0	0
Le Rhône	80 hp	620	0	0
Le Rhône	110 hp	771	10	0
Napier Lion	400 hp	1,897	10	0

		£	s.	d.
Rolls-Royce Eagle II, III, and IV	250 hp	1,430	0	0
Rolls-Royce Eagle V	175 hp	1,721	10	0
Rolls-Royce Eagle VI and VII	350 hp	1,919	10	0
Rolls-Royce Eagle VIII	360 hp	1,622	10	0
Rolls-Royce Falcon I, II, and III	190 hp	1,210	0	0
Rolls-Royce Falcon IV	225 hp	1,617	0	0
RAF 1a	100 hp	522	10	0
RAF 3a	200 hp	1,210	0	0
RAF 4a	150 hp	836	0	0
Renault	80 hp	522	10	0
Salmson	200 hp	968	0	0
Siddeley Puma	230 hp	1,089	0	0
Sunbeam Maori	250 hp	1,391	10	0
Sunbeam Arab	200 hp	1,017	10	0
Wolseley-Hispano	200 hp	946	0	0
Wolseley-Hispano Viper	200 hp	814	0	0

APPENDIX V

Aircraft Nomenclature, 1918

The inital letters to be used by designing companies were as follows*:

Aircraft Manufacturing Co Ltd	AM or AB
Armstrong Whitworth and Co Ltd	AR or AW
Austin Motor Co Ltd	AU or AS or OS
Beardmore and Co Ltd	BE
Blackburn Aeroplane Co Ltd	BL or BU
Boulton and Paul Ltd	BO
British Aerial Transport Co Ltd	BA
British and Colonial Aeroplane Co Ltd	BR or CO or KO
Fairey Aviation Co Ltd	FA or PHA
Felixstowe, RNAS	FE or PHE
Grahame-White Aviation Co Ltd	GA
Grain, RNAS	GR or GI
Handley Page, Ltd	H
Martinsyde, Ltd	MA

* Reproduced from T.D.I. 506A, 1918 (Technical Department Instruction).

Nieuport and General Aviation Co Ltd	NI
Norman Thompson Flight Co Ltd	NO
Parnall and Sons Ltd	PA
Phoenix Dynamo Manufacturing Co Ltd	PHO or FO
A.V. Roe and Co Ltd	RO or RHO
Royal Aircraft Factory	RA or RH A
Fredk. Sage and Co Ltd	SE or CE
Short Bros Ltd	SH
Siddeley-Deasy Motor Car Co Ltd	SI or SY or CI or CY
Sopwith Aviation Co Ltd	SO or SA or SN
Supermarine Aviation Co Ltd	SU or SW
Vickers, Ltd	U or V
Westland Aircraft Co Ltd	WE or WA or YE

Aircraft Names

Aircraft with One Engine Only*

Type of Design	*Land-based or carrier-aircraft*	*Seaplanes*
Single-seat	Reptiles (except snakes), land birds (except of prey)	
Multi-seat	Mammals (except felidae)	Waterfowl, fishes

Aircraft with more than One Engine

Gross weight		
Up to 11,000 lb	Inland towns in England and Wales	Seaboard towns in England and Wales
11,000 lb to 20,000 lb	Inland towns in Scotland and Ireland	Seaboard towns in Scotland and Ireland
20,000 lb to 45,000lb	Male historical or mythological proper names (excluding names of stars and planets)	Female historical or mythological proper names (excluding names of stars and planets)
Over 45,000 lb	Attributes terminating in ous, ant and ent	Terminating in ic, al and er

Note: The names excluded are reserved for engine designs.

* Reproduced from T.D.I. 538, 1918 (later to become AP. 547).

APPENDIX VI

Aircraft Production 1914–18

Total airframes manufactured in Great Britain	55,093
Total aircraft engines manufactured in Great Britain	41,034
Airframes purchased abroad	3,051
Aircraft engines purchased abroad	16,897

France built a total of 67,982 airframes and 85,317 engines, Italy is said to have made 20,000 airframes and 38,000 engines and, in 21 months of participation, the USA produced 15,000 aeroplanes and 41,000 engines. German production up to January 1919 was 47,637 airframes and 40,449 engines.

Total number of Allied aeroplanes on Western, Italian and Macedonian Fronts, Middle East, Mediterranean, and Home Defence in June 1918:

French	3,857	United States	180
British	2,630	Belgian	127
Italian	520		

Total number of RAF Squadrons using major types October 1918:

Armstrong Whitworth F.K.8	8	Felixstowe F.2A	10
B.E.2e	4	Felixstowe F.3	9
Bristol F.2B Fighter	17	Handley Page O/400	8
D.H.4	7	R.E.8	19
D.H.9	27	S.E.5a	16
D.H.9A	4	Sopwith Camel	32
F.E.2b	12	Sopwith Dolphin	5

INDEX

Page numbers in italics refer to illustrations.

DATE DUE

JAN 2 8			
FEB 1 6			